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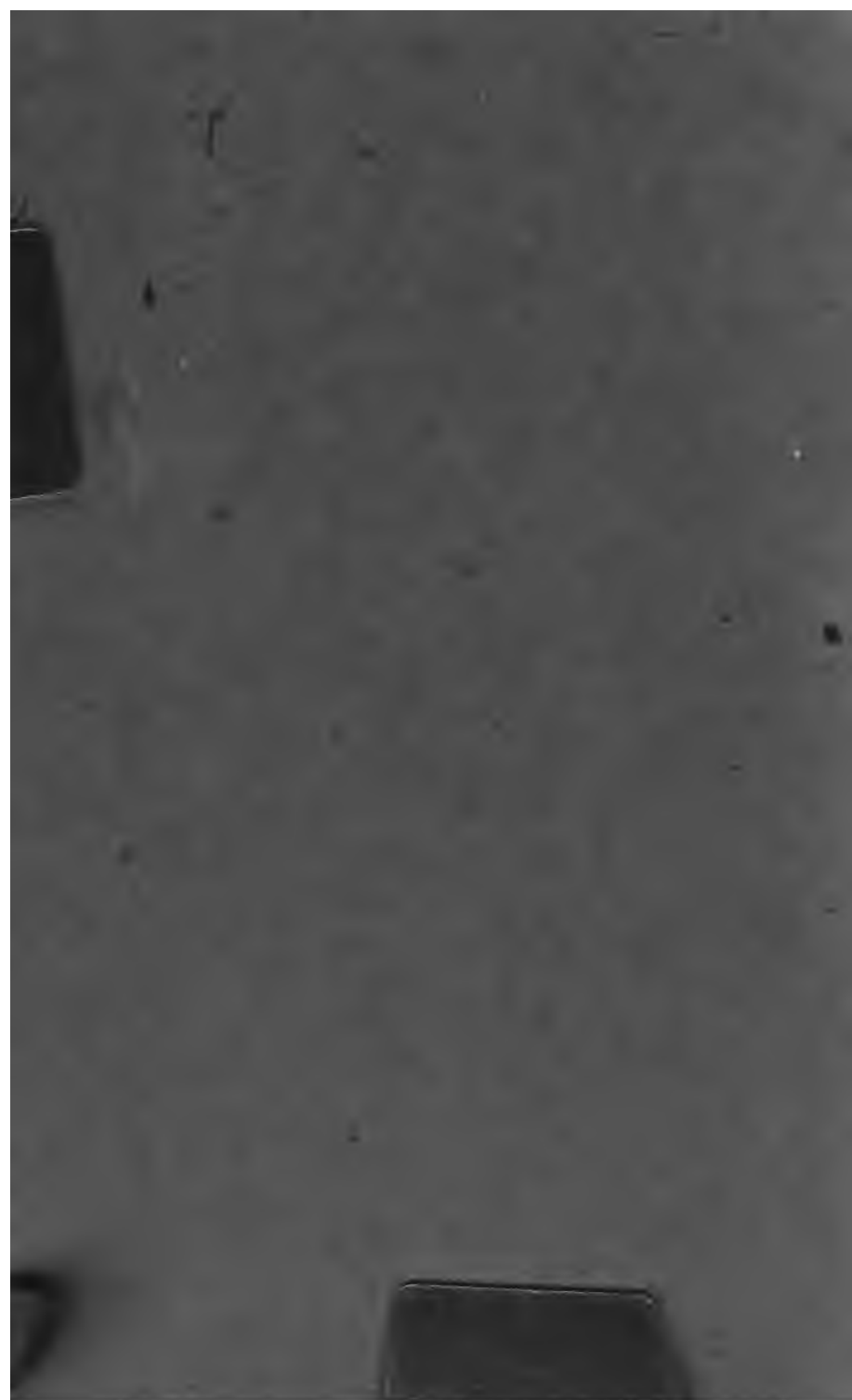
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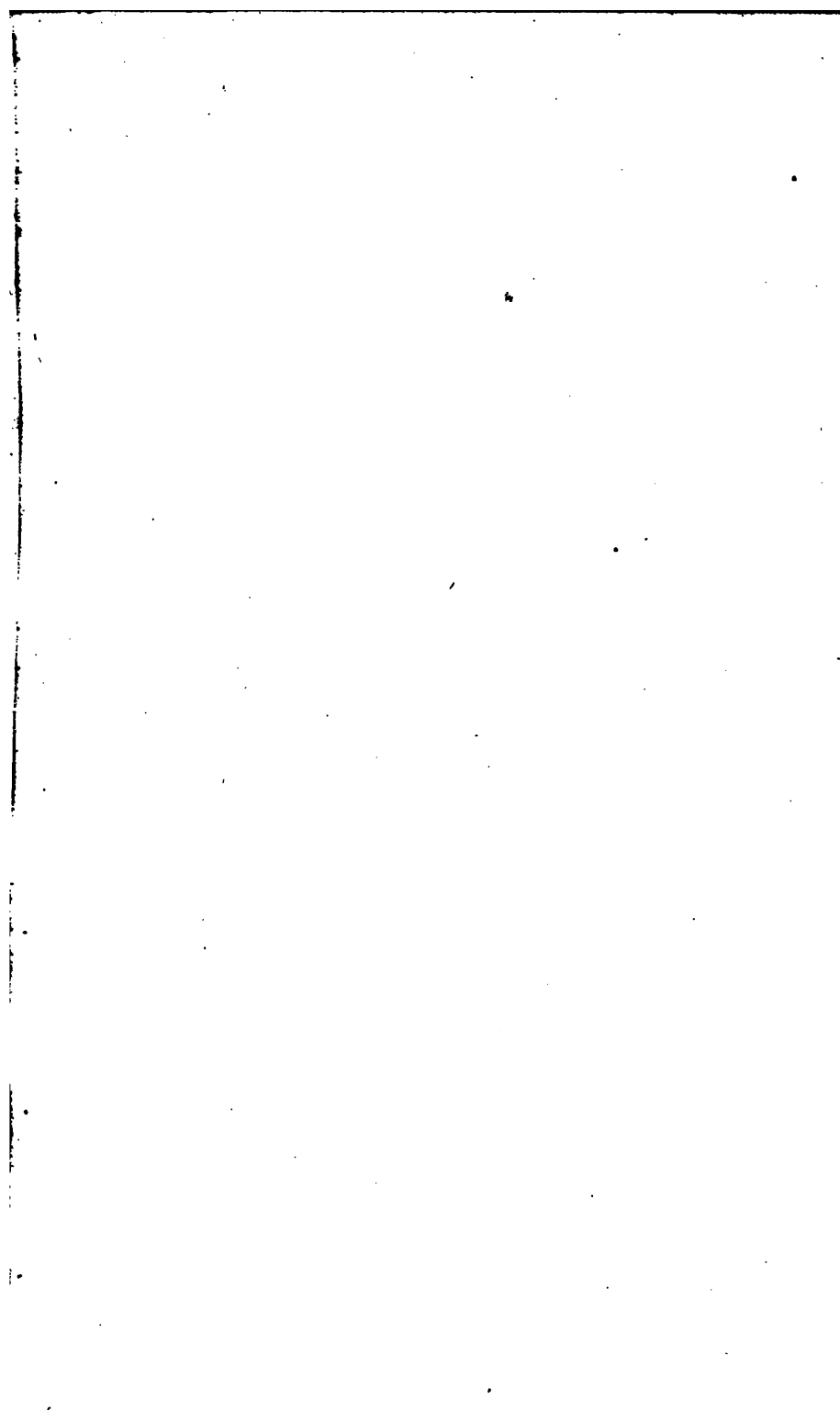
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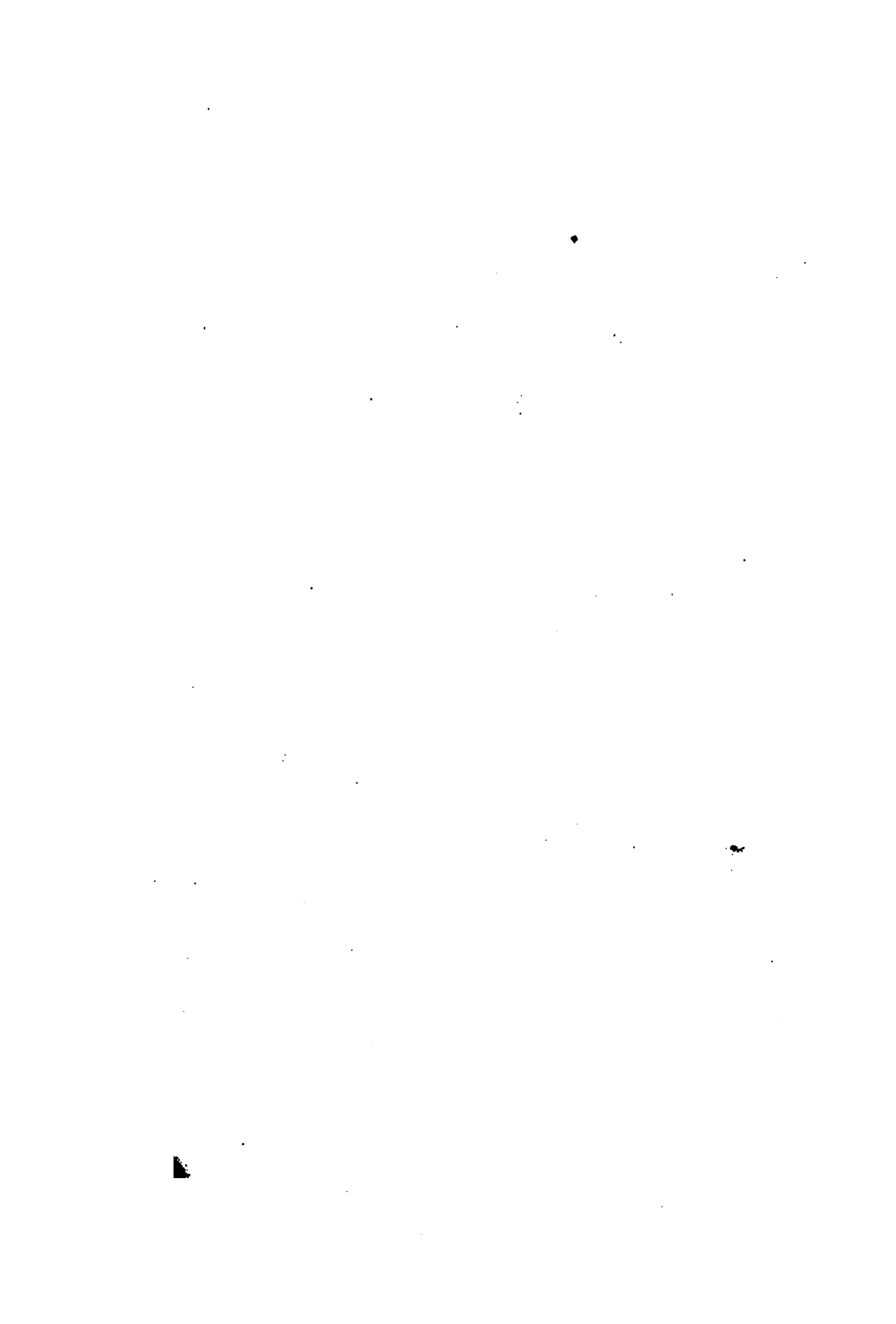
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MONTHLY NOTICES  
OF THE  
ROYAL ASTRONOMICAL SOCIETY,  
CONTAINING  
PAPERS,  
ABSTRACTS OF PAPERS,  
AND  
REPORTS OF THE PROCEEDINGS  
OF  
THE SOCIETY,

*FROM NOVEMBER 1848, TO JUNE 1849.*

WITH ONE SUPPLEMENT.

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VOL. IX.

BEING THE ANNUAL HALF-VOLUME OF THE MEMOIRS AND PROCEEDINGS  
OF THE ROYAL ASTRONOMICAL SOCIETY.

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1849.

*The Council is not able to exercise systematic control over the Monthly Notices without retarding the publication so much as greatly to subtract from its usefulness. The responsibility therefore rests chiefly on the Editor, who again begs to have it understood that his task is principally confined to compression and arrangement. The articles are to be estimated merely by their intrinsic merits, or by the reputation of their respective authors. A note is sometimes added to call the attention of the reader, or to recommend some precaution, and for these alone the Editor is responsible.*

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# ROYAL ASTRONOMICAL SOCIETY.

VOL. IX.

November 10, 1848.

No. 1.

CAPT. W. H. SMYTH, R.N., Vice-President, in the Chair.

Major-General Sir Wm. Morrison, K.C.B. was balloted for, and duly elected a Fellow of the Society.

*Discovery of a new Satellite of Saturn.\** By Mr. W. C. Bond, Director of the Observatory of Cambridge, U. S.

"As it may be interesting to the Society to know the evidence indicating the existence of an eighth satellite of *Saturn*, I subjoin, somewhat in detail, our observations upon it.

"On the 16th September, a point of light, resembling a star of the 17th magnitude, was noticed in the plane of *Saturn's* ring, between *Titan* and *Japetus*, by Mr. G. P. Bond, and entered by him in his diagram of the satellites and stars in the neighbourhood. On the 18th it was again seen similarly situated, and was recorded by us both, with a doubt expressed as to its character.

"The recurrence of nearly the same appearance on the 19th, induced us to apply the micrometer, with which the following measures were obtained from the object in question, which, for convenience, we shall designate by *x*.

1848. Sept. 19th, at 9 <sup>h</sup> 40 <sup>m</sup> , <i>x</i> precedes <i>Japetus</i> .....	137"	} Measured in the direction of the plane of the ring.
<i>Japetus</i> precedes a star ...	344	
12 00 <i>x</i> precedes <i>Japetus</i> .....	141	
<i>Japetus</i> precedes the star...	366	
13 15 <i>x</i> precedes <i>Japetus</i> .....	143	
<i>Japetus</i> precedes the star...	375	

"These measures indicated that the suspected body partook of the retrograde motion of *Saturn*. At 13<sup>h</sup> 30<sup>m</sup>, the distance of *x* from *Saturn's* centre was 256"; *x* following *Saturn* in the direction of the plane of the ring.

"A map of the stars in the path of *Saturn*, for the two following nights, was made as a security against mistakes.

"The evening of the 20th proved cloudy.

"On the 21st the new satellite was compared with a star following it, near the plane of the ring.

Sept. 21st at 11<sup>h</sup> 34<sup>m</sup> distance of *x* from star 276"

12 11	—	284
12 51	—	293

\* See vol. viii. No. 9, for the simultaneous discovery of the same satellite by Mr. Lassell.

"The distance of  $x$  from the centre of Saturn was found to be,

Sept. 21, at 12 <sup>h</sup> 30 <sup>m</sup> , $x$ following Saturn 220"	1 measure.
22 10 30 ——— 192	5 measures.
23 9 05 ——— 145	5 "
28 9 00 $x$ preceding Saturn 156	5 "

"On each of these nights, with the exception of the 22d, the observations were continued long enough to identify the satellite by its motion.

"The presence of the moon prevented our obtaining further observations of the new satellite till the 13th of October, although we lost much time in observing accidental stars, which could only be distinguished from the satellite by their not partaking of the motion of Saturn.

"On the 13th of October it was again seen following Saturn,

At 7<sup>h</sup> 40<sup>m</sup>  $x$  distant from centre of Saturn 202"

Oct. 14 7 00 $x$ ———	152
----------------------	-----

"The motion of  $x$  among the stars was sensible in three hours.

Oct. 15, at 9<sup>h</sup> 35<sup>m</sup>  $x$  distant from centre of Saturn 92"-4,  $x$  following.

"The foregoing positions are approximately satisfied by a periodic time of 21 days.

"The orbit is nearly coincident with the plane of the ring."

We are informed by Mr. Everett, that the name selected for the satellite discovered by Mr. Bond is "*Hyperion*."

Mr. Lassell complains, "that he has been completely baffled by the weather, which has never been clear, except on moonlight nights." He suspects that *Hyperion* varies considerably in brightness.

### Transit of Mercury.\* Nov. 8-9, 1848.

CAMBRIDGE.

(Professor Challis.)

Greenwich M.T.

External contact	23 5 30 <sup>h m s</sup> 0	} Professor Challis, Northumberland Equat <sup>l</sup> , power 215.
Internal contact	23 6 47 <sup>h m s</sup> 8	
—	23 6 47 <sup>h m s</sup> 0	{ Mr. Breen, 5-foot Equat <sup>l</sup> , power 120.

"The external contact was noted when planet had made a very small impression on the sun's limb. The internal contact well observed."

\* Several gentlemen have misunderstood the description of the transit inserted in p. 550 of the *Nautical Almanac*, and so lost the *external* contact, which is, however, a very unsatisfactory phenomenon. The description in the *N.A.* applies to the transit as seen through an inverting telescope, *i. e.* the north, west, and east are the upper, right-hand, and left-hand limb, as seen in the telescope. This would have been evident on referring to the elements at p. 552. In the *N.A.* for 1849, p. xx, the Superintendent stated, to prevent such mistakes, "that the angles of contact have reference to the phases as seen in an inverting telescope."

GREENWICH, *Hospital School.*

(MM. E. and J. Riddle.)

Greenwich M.T.

External contact  $23^h 5^m 38^s$  E. Riddle.

—  $23^h 5^m 36^s$  J. Riddle.

"Both observers imagined that they saw some undulation of an atmosphere surrounding the planet. The true contact probably had begun before it was noted by the observers."

LIVERPOOL. 9-foot Equatorial Reflector, power 101. (Mr. Lassell.)

*Distances of Centre of Mercury from Sun's Limb, E. and W.*

1848. Nov. 9	Greenwich M.T. Planet—2d Limb.			Greenwich M.T. 1st Limb—Planet.		
	$^h$	$^m$	$^s$	$^h$	$^m$	$^s$
	0	53	1	3	8	13
	4	15	2	13	7	0
	6	38	4	15	0	7
	9	12	7	17	7	1
	11	2	0	19	47	4
	15	22	2	3	22	9
	51	42	6			
	54	45	1			
	0	56	50			

*Distances of Centre of Mercury from Sun's Limb, N. and S.*

1848. Nov. 9	Greenwich M.T. S. Limb—Planet.			Greenwich M.T. Planet—N. Limb.		
	$^h$	$^m$	$^s$	$^h$	$^m$	$^s$
	1	11	28	2	53	56
	1	14	57	2	56	32
	1	16	27	2	58	3
	1	19	7	3	0	3
	1	21	30	3	1	27

"The day very fine, and the atmosphere pretty steady, though occasionally disturbed, especially in the early observations."

ASHURST.\*

(Mr. Snow.)

Ashurst Sid. Time.

External contact.....  $14^h 20^m 45^s.55$  } 5-foot equatoreal,  
Internal contact.....  $14^h 21^m 7^s.55$  } power 75.

"On entering the sun's limb the planet was decidedly pear-shaped, but became pretty round on forming the internal contact."

A careful measure with the double-wire micrometer gave the diameter of the planet

$=9''.63$  at  $14^h 45^m$  Sid. Time.

\* Latitude .....  $51^\circ 15' 58''$  N.

Longitude ...  $0^h 1^m 10^s.1$  W.

*Transit of Mercury.*

The first limb of the sun and the planet were each observed on the meridian over seven wires of the transit instrument.

First Limb of Sun at  $14^{\text{h}} 57^{\text{m}} 58^{\text{s}}.57$  Ashurst Sid. Time.

Mercury, centre.....  $14^{\text{h}} 59^{\text{m}} 46^{\text{s}}.77$  —

“The clock error well determined.

“The following differential observations were made with the 5-foot equatoreal, in Ashurst Sid. Time:—

*Observations in R.A.*

Sun's 2d Limb.	Mercury, Centre.	Sun's 1st Limb.	Mercury, Centre.
$\begin{smallmatrix} \text{h} & \text{m} & \text{s} \end{smallmatrix}$	$\begin{smallmatrix} \text{h} & \text{m} & \text{s} \end{smallmatrix}$	$\begin{smallmatrix} \text{h} & \text{m} & \text{s} \end{smallmatrix}$	$\begin{smallmatrix} \text{h} & \text{m} & \text{s} \end{smallmatrix}$
14 53 51.55	14 53 35.75	17 33 32.35	17 34 32.55
15 9 29.55	15 9 7.85	17 45 57.55	17 46 52.05
16 11 29.55	16 10 55.55	18 4 39.55	18 5 27.05
16 15 14.55	16 14 29.15	19 11 14.55	19 11 37.05
16 17 25.05	16 16 39.55	19 12 52.55	19 13 14.55

*In Declination.*

Ashurst Sid. Time.	S.L.—Planet.	Ashurst Sid. Time.	Planet—N.L.
$\begin{smallmatrix} \text{h} & \text{m} & \text{s} \end{smallmatrix}$	$\begin{smallmatrix} \text{h} & \text{m} & \text{s} \end{smallmatrix}$	$\begin{smallmatrix} \text{h} & \text{m} & \text{s} \end{smallmatrix}$	$\begin{smallmatrix} \text{h} & \text{m} & \text{s} \end{smallmatrix}$
14 57 30	74.1.5	19 16 40	449.4
15 14 40	809.2		
16 19 55	845.5		
17 20 20	993.2		
17 21 55	998.3		
17 24 40	1005.4		
17 31 25	1030.8		
17 42 30	1046.5		

“The above are the results of observation merely.”

Dr. Foster observed the transit at Bruges. He remarks the extreme *blackness* of the planet compared with that of the spots, the intensities he estimates as 8: 5. The telescope used was an achromatic, by Brand of Bruxelles, an excellent defining instrument, power 200. Dr. Foster states, that the planet had rather the appearance of a *globe* than of a *disc*, and that the difference of blackness between the planet and the spots was less remarkable when he used a reflector with a red shade. A diagram accompanied Dr. Foster's letter.\*

The Astronomer Royal mentioned at the meeting, that the transit of *Mercury* was observed, by many observers, with several telescopes at the Royal Observatory, and in different ways, (the image of the planet being received, in one instance at least, on a screen). An appearance bearing analogy to Baily's *beads* was seen only in one instance, by Mr. Main, who observed an image thrown on a screen. The Astronomer Royal also stated, that the steadiness of the planet and of the sun's limbs was much greater in the telescopes placed out of doors than in those under cover.

\* Dr. Foster wishes to direct the attention of astronomers to the apparent connexion between spots in the sun and an extremely wet season.

*Extract of a Letter from Professor Schumacher.*

“The passage of *Mercury* here has shewn some curious circumstances.

“I must premise, that the limb of the sun was undulating, and that at Altona the instruments were shaken by many passing carriages.

“I could not observe the exterior contact. When I saw *Mercury* he had already somewhat entered, viz.:—

At 23<sup>h</sup> 46<sup>m</sup> 34<sup>s</sup> Altona M.T.

“I saw a fine line of light between *Mercury* and the sun; but it disappeared immediately afterwards, and the separation was first visible and permanent at

23<sup>h</sup> 46<sup>m</sup> 52<sup>s</sup>

“Dr. Petersen observed the same contact in the Meridian Circle during the culmination, at

23<sup>h</sup> 46<sup>m</sup> 9<sup>s</sup>

“Dr. Olde and M. Sonntag observed the contacts;—

	Exterior.			Interior.		
	<sup>h</sup>	<sup>m</sup>	<sup>s</sup>	<sup>h</sup>	<sup>m</sup>	<sup>s</sup>
Mr. Sonntag...	23	44	51	23	46	33
Dr. Olde.....				23	46	41

“At Hamburg, M. Rümker observed with the meridian circle,—

Interior contact 23<sup>h</sup> 46<sup>m</sup> 40<sup>s</sup> Hamb. M.T.

	Exterior.			Interior contact.		
	<sup>h</sup>	<sup>m</sup>	<sup>s</sup>	<sup>h</sup>	<sup>m</sup>	<sup>s</sup>
M. Weyer.....	23	45	24	23	46	56
M. G. Rümker —	—	—	27			
M. Jürgensen .				—	—	58
M. Brymann. .	—	—	47	—	—	52

“Now if you will reduce the Hamburg Observations with —7<sup>s</sup> to Altona M.T. you will see,

1. That my first moment agrees nearer than can be expected with the observations of M. Sonntag and M. Charles Rümker.
2. That my second moment comes near to the four Hamburg observers.
3. That Dr. Petersen is greatly in advance of all the other eight observers.

*Meridian Observations of Mercury.*

	<sup>h</sup>	<sup>m</sup>	<sup>s</sup>		Dec.	<sup>°</sup>	<sup>'</sup>	<sup>″</sup>	
At 23	46	42	Hamb. M.T.	Mercury	—17	3	32	2	M. Rümker.
23	46	14	Altona M.T.		—17	3	39	5	Dr. Petersen.

M. Le Verrier has published a new theory of *Mercury* in the *Connaissance des Temps* for 1848, and promises tables founded on the theory. In the *Comptes Rendus* of the 13th of November last, he shews that his formulæ give the first internal contact, seen from the centre of the earth, at

Paris M. T.  
 Nov. 8 <sup>h m s</sup> 23 16 43 using the value of sun's diameter in the *Connaissance*.  
           16 47 ——— ——— *N. Almanac*.  
           16 58 ——— determined by himself, at = 32' dist<sup>ce</sup> 1

He remarks, that his formulæ make the phases of transit about 4 minutes *later* than the *Connaissance*, which is nearly 20<sup>s</sup> *earlier* than the *Nautical Almanac*.

## URANUS.

CAPE OF GOOD HOPE. In the Meridian. (Mr. Maclear.)

R.A.				N.P.D.			
1847.	h	m	s	°	'	"	
Sept. 19	1	3	52.17	...	...	...	
20		3	43.78	...	...	...	
21		3	35.49	83	57	37.19	
25		3	1.40	...	...	...	
26		2	52.78	...	...	...	
28		2	35.36	...	...	...	
29		2	26.41	...	...	...	
30		...	...	84	5	41.16	
Oct. 1		2	8.93	6	34.96	...	
4		1	42.14	...	...	...	
7		...	...	12	8.25	...	
8	1	1	5.95	...	...	...	
12		...	...	16	47.79	...	
13		...	...	17	41.78	...	
16	0	59	54.03	...	...	...	
17		59	45.02	...	...	...	
18		...	...	22	17.05	...	
20		59	18.44	24	4.02	...	
21		59	9.61	24	53.67	...	
22	0	59	0.97	84	25	50.95	
R.A.				N.P.D.			
1847.	h	m	s	°	'	"	
Oct. 23	0	58	52.23	84	26	45.53	
24		58	43.75	...	...	...	
25		58	35.12	28	31.12	...	
27		58	18.00	...	...	...	
28		58	9.73	...	...	...	
29		58	1.30	31	55.60	...	
30		57	53.03	...	...	...	
Nov. 1		57	36.81	...	...	...	
5		57	5.24	...	...	...	
6		56	57.67	38	23.06	...	
10		56	28.12	...	...	...	
11		56	21.06	42	4.22	...	
13		56	7.18	43	26.60	...	
15		55	53.93	...	...	...	
16		55	47.40	45	25.17	...	
20	0	55	23.04	47	52.74	...	
23		...	...	49	31.01	...	
25		...	...	50	35.41	...	
27		...	...	84	51	32.57	

## NEPTUNE.

CAPE OF GOOD HOPE. In the Meridian. (Mr. Maclear.)

1847.	h	R.A.	N.P.D.	1847.	h	R.A.	N.P.D.
Aug. 12	22	6 19'86	102 18 9'80	Sept. 25	22	1 59'27	102 42 5'50
16		5 55'25	20 27'34	28		...	43 23'22
18		5 42'58	21 37'19	29		1 40'15	...
19		5 36'41	22 11'64	Oct. 1		1 31'14	...
20		5 30'17	22 47'43	3		...	45 22'64
21		5 23'76	23 22'49	4		1 18'01	45 45'40
25		4 58'77	25 41'47	8		...	47 12'20
26		4 52'34	26 17'92	9		0 58'47	...
27		4 46'14	26 51'95	16		...	49 34'91
31		4 21'42	...	17		0 32'20	...
Sept. 1		4 15'10	29 44'04	19		0 26'71	...
2		4 9'03	...	20		0 24'17	...
3		4 2'89	30 51'77	21		0 21'85	50 44'96
4		3 56'72	31 24'05	22		0 19'44	...
6		3 44'72	32 35'43	24		0 15'31	...
7		3 38'74	33 5'59	25		0 13'29	...
12		3 9'53	35 45'90	26		...	51 37'51
13		3 3'48	36 17'10	27		0 9'67	...
14		2 57'89	...	28		0 8'14	51 52'91
15		2 52'08	37 17'62	29		0 6'46	...
16		2 46'64	37 49'05	30		0 5'33	52 5'94
17		2 41'02	38 18'89	Nov. 1		0 2'88	...
18		2 35'84	38 49'03	4	22	0 0'51	...
19		2 30'37	...	5	21	59 59'75	52 32'70
20		2 24'92	39 45'98	6		59 59'30	102 52 34'81
21		2 19'56	40 13'87	7		59 59'26	...
22		2 14'39	40 43'54	8	21	59 59'03	...
23	22	2 9'37	102 41 12'35				

Mr. Maclear has given the following mean places of stars for Jan. 0, 1847, which have been compared with *Neptune*.

	R.A.	Obs.	N.P.D.	Obs.
	h m s		° ' "	
B.A.C. 7722	22 2 26'36	35	102 18 53'8	2
Star 8th mag.	22 8 35'02	48	102 24 30'0	5
B.A.C. 7747			102 40 47'7	13

HAMBURG.

Equatoreal.

(M. Rümker.)

1848.	Hamburg M.T.	R.A.	Dec.
July 7	h m s	h m s	° ' "
	12 0 56'8	22 18 9'22	-11 15 45'7
8	13 11 32'8	22 18 5'33	-11 16 6'7

## With the Meridian Circle.

1848.	h	m	s	Dec.	1848.	h	m	s	Dec.
July 10	22	17	56.81	-11 16 59.3	Sept. 4	22	12	41.40	-11 47 31.5
11		17	52.92	17 23.9	7	12	23.24	49 15.6	
12		17	48.60	17 46.6	9	12	11.45	50 23.6	
22		17	2.30	22 27.1	12	11	53.95	52 0.7	
23				22 48.7	14	11	42.43	53 6.2	
27	16	36.40		25 1.2	15	11	36.72	53 37.0	
29	16	25.38		26 1.4	20	11	8.98	56 9.9	
30	16	20.03		26 35.4	21	11	3.63	56 39.9	
Aug. 7	15	33.86		31 4.8	23	10	53.26	57 40.6	
9	15	21.99		32 12.3	24	10	48.21	11 58 7.9	
11	15	10.02		33 24.9	30	10	18.79	12 0 49.0	
13	14	58.26		34 34.1	Oct. 1	10	14.20	1 15.5	
18	14	27.22			2	10	9.36	1 40.8	
22	14	2.17		39 55.1	6	9	52.34	3 13.5	
25	13	43.70		41 40.5	7	9	48.18	3 33.5	
28	13	24.75		43 28.1	10	22	9 36.73	-12 4 39.1	
30	22	13 12.37	-11 44 38.9						

## Ephemeris for Greenwich Mean Midnight. By Mr. Adams.

1848.	R.A.			N.P.D.			1848.	R.A.			N.P.D.		
Nov. 30	22	h	m	102	'	s	Dec. 29	22	h	m	101	'	s
			3 45		7	3 1				9 87		55	4 2
Dec. 1			6 12		6	47 6				15 89		54	30 3
2			8 92			31 4				22 00		53	55 9
3			11 85			14 4							
4			14 91		5	56 8	1849.			28 21			21 0
5			18 07			38 4	Jan. 1			34 51		52	45 5
6			21 40			19 4	2			40 90			9 6
7			24 83		4	59 7	3			47 38		51	33 1
8			28 38			39 3	4			53 96		50	56 2
9			32 06			18 3	5		11	0 62			18 8
10			35 86		3	56 1	6		12	7 36		49	40 9
11			39 78			34 2	7			14 19			2 5
12			43 82			11 2	8			21 10		48	23 7
13			47 98		2	47 5	9			28 09		47	44 5
14			52 25			23 2	10			35 16			4 8
15			56 65		1	58 2	11			42 31		46	24 7
16	10		1 15			32 6	12			49 53		45	44 1
17			5 78			6 4	13		12	56 83			3 2
18			10 52		0	39 5	14		13	4 20		44	21 9
19			15 37			12 0	15			11 64		43	40 2
20			20 34	101	59	43 9	16			19 14		42	58 1
21			25 41			15 1	17			26 72			15 6
22			30 60		58	45 8	18			34 36		41	32 8
23			35 90			15 9	19			42 06		40	49 6
24			41 30		57	45 4	20			49 82			6 1
25			46 81			14 2	21			57 64		39	22 3
26			52 42		56	42 6	22	13		5 53		38	38 1
27	10		58 14			10 3	23	14		13 46	101	37	53 6
28	22	11	3 96	101	55	37 5	24	22	14				

## IRIS.

HAMBURG.

Equatoreal.

(M. Rümker.)

1848.		Hamburg M.T.	R.A.	Decl.
		<sup>h</sup> <sub>h</sub> <sup>m</sup> <sub>m</sub> <sup>s</sup> <sub>s</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>
Sept.	23	14 34 54.2	130 22 23.8	+ 16 15 35.6
	26	15 38 1.3	131 47 42.8	15 48 24.1
Oct.	1	14 51 26.6	134 3 32.0	15 0 6.8
	3	16 49 50.8	134 58 59.6	14 39 47.6
	6	15 47 26.3	136 16 6.8	14 12 5.0
	25	16 23 35.5	143 51 10.8	11 4 33.9
	26	15 10 30.2	144 11 46.0	10 55 28.4
	28	16 4 1.4	144 55 16.6	+ 10 35 55.6

## HEBE.

HAMBURG.

Equatoreal.

(M. Rümker.)

1848.		Hamburg M.T.	R.A.	Decl.
		<sup>h</sup> <sub>h</sub> <sup>m</sup> <sub>m</sub> <sup>s</sup> <sub>s</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>
Sept.	4	14 28 9.4	83 47 22.9	+ 7 59 51.4
	5	14 36 55.9	84 11 19.4	7 56 29.9
	6	13 58 33.7	84 35 20.7	7 52 55.3
	7	14 23 11.7	84 59 25.5	7 49 26.2
	9	13 58 53.3	85 46 6.6	7 42 5.8
	12	14 35 57.4	86 55 8.0	7 30 11.6
	14	13 8 23.0	87 38 0.5	7 22 31.0
	15	15 46 48.8	88 0 47.0	7 17 34.1
	20	13 29 28.8	89 44 35.2	6 56 12.0
	21	13 12 58.0	90 4 9.5	6 51 51.1
	22	13 26 41.3	90 24 2.0	6 47 3.4
	23	12 55 57.6	90 42 54.5	6 42 13.4
	24	12 55 40.4	91 1 51.8	6 37 51.9
	26	14 9 40.0	91 40 18.5	6 27 21.5
	30	13 37 57.8	92 49 38.9	6 7 36.5
Oct.	1	12 38 5.7	93 3 41.6	6 0 56.0
	7	12 30 6.6	94 37 33.3	5 31 12.0
	8	13 6 57.6	94 51 53.5	5 25 59.4
	10	11 41 56.2	95 17 50.6	5 15 49.7
	25	11 49 29.0	97 42 41.5	3 38 15.6
		14 54 4.2	97 43 39.9	3 37 41.7
	26	11 46 58.4	97 48 50.6	3 53 26.9
		13 21 6.6	97 49 9.2	3 53 10.1
	28	14 10 38.7	98 20 39.7	+ 3 44 56.4

## VESTA.

HAMBURG.

Meridian Circle.

(M. Rümker.)

1848.	R.A.			Decl.			1848.	R.A.			Decl.		
	h	m	s	°	'	"		h	m	s	°	'	"
Sept. 7	0	17	42.33	—10	33	24.1	Sept. 24	0	2	36.43	—12	31	51.6
9	0	16	3.99	10	48	47.8	30	23	57	12.46	13	3	1.7
12	0	13	30.46	11	11	24.6	Oct. 1	23	56	20.45	13	7	28.3
14	0	11	44.87	11	26	4.2	6	23	52	11.99	13	26	21.0
15	0	10	51.01	11	33	16.2	7	23	51	25.12	13	29	22.8
20	0	6	17.23	12	7	18.3	10	23	49	11.17	—13	37	9.6
23	0	3	31.52	—12	26	0.7							

## MAUVAIS' THIRD COMET.

CAMBRIDGE, U.S.

(Mr. W. C. Bond.)

"By five micrometrical comparisons with 18 *Leonis*, its position was found to be,

1848.	Cambridge M.T.			R.A.			Decl.		
	h	m	s	h	m	s	°	'	"
April 21	9	9		9	37	41.8	+12	29	7

referred to the mean equinox of Jan. 1.

"The comet was faint, but admitted of pretty good determinations. It exhibited to the last the star-like scintillations which have all along distinguished it."

## ENCKE'S COMET.

"The comet was first seen at Cambridge, U. S., on August 27. It was a faint patch of misty light, 1' or 2' in diameter.

"At 14<sup>h</sup> local M.T., R.A. = 3<sup>h</sup> 19<sup>m</sup> 28<sup>s</sup>, Dec. + 31° 57' by the instrument corrected.

1848.	Cambridge M.T.			Star—Comet.			No. of Obs.	Star.
	h	m	s	R.A.	N.P.D.			
Aug. 29	12	50	53	+0 9.33	+5 35.2	18	9	<i>a</i>
30	12	57	36	+0 18.97	—3 51.3	12	10	<i>b</i>
31	12	40	1	+1 20.05	—2 20.8	10	10	<i>c</i>

## Approximate Places of Stars of Comparison.

	mag.	R.A.			Decl.			
		h	m	s	°	'	"	
<i>a</i>	10	3	23	40	+32	31		{ Another star precedes this by 13.6
<i>b</i>	10–11	3	26	6	+33	2		
<i>c</i>	9	3	29	20	+33	21		

"From the faintness and diffusion of the comet, these determinations may be uncertain 10" or 15". Something like a centre is, however, suspected."

HAMBURG.

(M. Rümker.)

	Hamburg M.T.	R.A.	Decl.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
Sept. 23	8 51 8	71 39 16.4	+44 13 55.0
24	8 54 27	73 9 45.6	44 52 30.8
Oct. 1	9 29 48	86 48 47.3	49 31 31.5
5	14 46 53	99 7 54.1	51 58 19.5
6	10 23 7	101 59 48.4	52 20 42.3
7	11 35 17	105 54 32.9	+52 43 15.9

PETERSEN'S SECOND COMET.

"On the evening of October 26, at 8 P.M. Dr. Petersen discovered a telescopic comet in the constellation *Draco*. It is tolerably large, and has an evident nucleus. It was carefully compared the same night with a small star, and its hourly motion found to be about + 11" in R.A. and + 1' 20" in N.P.D."

ALTONA.

(Professor Schumacher and Dr. Petersen.)

	Altona M.T.	R.A.	Decl.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
1848. Oct. 26	11 41 20.2	18 18 7.9	
	11 50 5.3		+63 11 53.3
Nov. 4	12 9 30.1	18 59 33.0	+57 45 41.6

BERLIN.

(Professor Encke.)

	Berlin M.T.	R.A.	Decl.	Arg. Zones.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>	
Oct. 28	8 27 43.9	276 38 1.3	+62 12 32.6	
29	7 59 50.3	277 44 51.5	61 39 38.7	
30	7 33 28.4	278 52 19.7	61 5 34.8	
Nov. 2	9 58 47.2	282 26 33.9	59 10 29.2	
7	6 36 39.0	288 6 2.4	55 44 58.1	xvi, 8 : xxxviii, 8
8	8 29 47.8	289 21 14.8	54 54 43.8	— 32 — 23
9	6 28 32.7	290 25 23.7	54 10 39.6	— 24
10	9 21 36.2	291 43 31.2	+53 14 58.2	xiv, 53

"If in Zone xvi. 32, you read 20.75 instead 19.75, which Professor Encke thinks should be done, the R.A. of Nov. 8 must be diminished 7".5."

HAMBURG.

(M. Rümker.)

	Hamburg M.T.	R.A.	Decl.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
1848. Oct. 28	9 14 27	18 26 42.49	+62 11 10.1
29	10 37 24	31 33.52	61 35 29.0
Nov. 2	8 11 52	18 49 30.19	+59 13 8.5

## Observations at Markree. (E. J. Cooper, Esq. &amp; A. Graham, Esq.)

	G.M.T.	Comet's R.A.	+Δ	Comet's Decl.	+Δ
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>		<sup>°</sup> <sup>'</sup> <sup>''</sup>	
Nov. 1	10 28 25.3	18 45 24.19 + [9.8237]		+ 59 46' 48.1" + [0.5290]	
2	8 58 8.0	18 49 45.53 + [9.7765]		59 10 46.0 + [0.2510]	
3	7 54 38.4	18 54 12.53 + [9.6911]		58 32 54.1 + [9.9272]	
7	7 43 48.1	19 12 47.86 + [9.6345]		+ 55 41' 5.0 + [0.0160]	
Nov. 1.	Piazzì xviii. 220	10 Comparisons by E. J. C. and A. G.			
	223				
2.	B.A.C. 6463	8 Comparisons by E. J. C. and A. G.			
3.	* observed with circle	10 Comparisons by A. G.			
	App. R.A. 18 <sup>h</sup> 52 <sup>m</sup> 7 <sup>s</sup> .88				
	App. Dec. + 58° 33' 9".3				
7.	Observed with circle	10 Comparisons by A. G.			
	R.A. 19 <sup>h</sup> 11 <sup>m</sup> 17 <sup>s</sup> .23				
	Dec. + 55° 41' 2".9				

*Elements.*

By Professor Encke, from Berlin Observations of Oct. 28, 30, and Nov. 2.

$T = 1849, \text{Jan. } 19^{\circ} 68270 \text{ Berlin M.T.}$

$\text{Log. } q = 9.982056$

$\pi = 63^{\circ} 8' 16.7$

$\Omega = 215^{\circ} 2' 3.9$

$i = 85^{\circ} 10' 55.0. \text{ Motion direct.}$

By Dr. Petersen and M. Sonntag, from the Altona Observations of Oct. 26 and Nov. 4, and the Berlin Observation of Oct. 30.

Perihelion Passage, 1849, Jan. 20.08372 Berlin M.T.

Long. Perihelion ...  $62^{\circ} 35' 15.3$  } App<sup>t</sup> Eq<sup>s</sup> Oct. 30

— Node .....  $214^{\circ} 40' 30.4$

$i$  .....  $85^{\circ} 26' 21.7$

$\text{Log. } q = 9.9840412. \text{ Motion direct.}$

Professor Schumacher says, — “Dr. Petersen has tried several suppositions to make the present comet go through the estimated (they are not observed) places of the comet of 1780, but cannot represent the latitudes of 1780 within  $40^{\circ}$ . The three observations are mere estimations, and the time of the observations is also estimated and supposed to be 7<sup>h</sup>. Olbers has given these estimations under the following form:—

		Longitude.	North Lat.
1780.	<sup>h</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
Oct. 18	7	viii 27 22	15 21
20	7	— 26 38	12 51
26	7	— 25 22	5 53½

“According to Dr. Petersen's Elements, the present comet will

pass its descending node on the last day of this year, and only 0.02 distant from the earth's orbit. I am curious to know if more approximate elements will confirm this vicinity of the two orbits."

By Mr. Graham, from the Altona Observation of October 26 and the Markree places of November 1 and 7.

T 1849, January 22.52 G.M.T.

$\pi$  ..... 62° 6' 10"

$\Omega$  ..... 212 21 38

$i$  ..... 87 7 4

Log.  $q$  ..... 9.98940. Motion direct.

By Mr. Hind, from the Observations of October 26, 29, and November 4.

T 1849, January 20.69169

$\pi$  ..... 62° 4' 42"

$\Omega$  ..... 214 11 49

$i$  ..... 85 46 50

Log.  $q$  ..... 9.985266. Motion direct.

By M. George Rümker, from Altona Observation, Oct. 26, and Hamburg Observations, Oct. 29 and Nov. 2.

Perihelion Passage, 1849, Jan. 21.0162811 Greenwich M.T.

Long. Perihelion... 61° 50' 21"

— Node..... 214 0 54.7

Inclination ..... 85 54 48.5

Long. Per. Dist. 9.986144. Motion direct.

### Occultations of Stars by the Moon. By Mr. Snow, at Ashurst.\*

				Immersion.			Emersion.		
				h	m	s	h	m	s
1847.									
June 1	$\zeta^1$ Sagittarii...	Ashurst ...	17	8	11.55		18	22	41.05
1848.									
Feb. 12	75 Tauri .....	— ...	4	38	54				
May 7	67 Geminorum	— ...	13	9	16				
—	$k$ Geminorum	— ...	13	33	32	14	8	21	
July 11	$\iota$ Libræ .....	— ...	16	15	20.6	16	47	28.6	

The instrument used at Ashurst is a 5-foot equatoreal, aperture 4 inches. The time is Ashurst Sidereal Time.

" $\zeta^1$  Sagittarii immersed, at the moon's bright limb, *slowly*, like a body with a disc. Emerged instantaneously.

"An emersion of *Aldebaran* was observed in London with a 3½-foot refractor, power 62. The star hung for about 5" on the moon's bright limb, but I saw no projection on the moon's surface. Definition very good."

\* Lat. 51° 15' 58" N. Long. 0° 1' 10" W.

*The Method in Use at the Cambridge Observatory of Measuring Differences of Right Ascension and North Polar Distance by an Equatoreal provided with Clock-movement, and of Correcting the Observations for Refraction.* By Professor Challis.

"Differences of north polar distance are usually measured by the Northumberland equatoreal, by means of a small sector of a large circle, on the limb of which are inscribed equidistant divisions, separated by an arbitrary but ascertained interval. A similar sector can be clamped to any part of the hour-circle, and differences of right ascension measured in an analogous manner. This is effected by an arrangement contrived by Mr. Airy (who contemplated the kind of observation here described), by which the instrument may be moved about its polar axis independently of the hour-circle, while the latter is carried nearly at the rate of sidereal time by a clock. The hour-circle sector has been substituted for the hour-circle itself, because the divisions of the latter are on brass, and not so well adapted for accurate bisection as those of the sector, which are on white metal; and because the equi-distance of the divisions, which is the essential condition, is more likely to be secured in a small portion of a circle than in a complete circle. The intervals of both sectors are subdivided by microscope-micrometers. The following is the method of taking the observations.

"It is generally required, and always desirable, to measure simultaneously differences of right ascension and north polar distance. Accordingly the object is bisected by the equatorially adjusted wire, *very near* the transverse wire, so that the rate of the clock, gaining or losing as the case may be, soon brings it upon the latter wire, the observer taking care, in the meantime, that it remains bisected by the other. The instant of simultaneous bisection by the two wires is noted, and the microscope-micrometers of the two sectors are then read off in integral intervals and revolutions, and parts of a revolution. This process is *commenced with the star*, or point of reference; the object referred is next observed in the same manner, and so on alternately, the series *concluding with the reference star*. In case the compared object be too faint for observation with micrometer wires, the practice with the Cambridge equatoreal is to use a diaphragm bounded by straight edges at right angles to each other, and the object being placed near the angular point in the prolongation of the edge which is equatorially adjusted, the instant at which its centre is brought into coincidence with the angular point by the clock's rate is noted. In other respects the operation is the same as that just described. The chronometer is compared with the transit-clock at the end of the series (sometimes, also, before its commencement), and finally the barometer and thermometer are read off.

"With respect to the reduction of the observations, the chief things to remark upon are the corrections for the clock's rate, and

for refraction. The differences of the hour-circle sector readings for the *star* are entirely due to these two causes, if the instrument be supposed to be in good adjustment. The star being known, and the times of bisection known, the effect of refraction on the hour angles are calculated for each observation of the star, by a process which will be presently stated. Corrections for refraction being applied to the hour-circle sector readings for the star, the remaining differences are due to the clock's rate, and, by comparison with the times of bisection, determine the rate. The *correction for rate of hour-circle* is a part of the loss or gain in the interval between *consecutive* bisections of the star, which bears the same ratio to the whole, as the interval from either bisection of the star to the bisection of the planet or comet bears to the interval between the two bisections of the star. The following is the formula for this correction, the sidereal times of the three bisections, in the order of their occurrence, being  $s_1, \sigma, s_2$ ; H being the excess of the hour-circle sector reading for the star at  $s_1$  above the reading at  $s_2$  converted into time; and R the excess of the correction for refraction in hour-angle for the star at  $s_1$  above that at  $s_2$  :—

$$\text{Correction for rate of hour-circle} = \frac{\sigma - s_1}{s_2 - s_1} (H + R).$$

This formula gives the quantity to be *added* to the algebraic excess of the sector reading for the comet or planet, above that sector reading for the star which was taken at the time  $s_1$ , and is sufficient for all cases.

“ It is to be remarked, that if the difference of the sector readings be affected by any other source of error acting proportionally to the time, as, for instance, want of adjustment of the instrument, such error is eliminated by the above calculation. For this reason, to ensure greater accuracy, the excess of the reading of the *declination* sector for the compared object, above that for the star at the time  $s_1$ , is also corrected by the process just indicated, although that excess is unaffected by the clock's rate. The formula for this purpose is precisely the same as that given above; H, in this case, representing the excess of the declination sector reading for the star at  $s_1$  above the reading at  $s_2$ , converted into arc; and R the excess of the correction for refraction in north polar distance for the star at  $s_1$  above that at  $s_2$ .

“ After applying the corrections now considered, it is presumed that the instrumental measures of differences of apparent right ascension and north polar distance are affected only by refraction. The total refractions for the star in R.A. and N.P.D. have been already required, and therefore the obvious course is to calculate, also, the total refractions for the planet or comet, and thence deduce the differences of refraction corresponding to the measured differences of R.A. and N.P.D. It may be questioned, whether any approximate formulæ, requiring only the calculation of differences of refraction, would lead to a less amount of calculation in this kind of observation. If P be the pole of the heavens, Z the

zenith of the observer, S the place of the object, and Z Q be drawn a perpendicular on P S, the formula used for the total corrections for refraction in R.A. and N.P.D. are the following :—

$$\text{Correction for refraction in N.P.D.} = A. \tan (PS - PQ)$$

$$\text{Correction for refraction in R.A.} = A. \frac{\tan ZQ}{15} \cdot \text{cosec. } PS \cdot \sec (PS - PQ)$$

The factor A is given by the tables in Bessel's *Astronomische Untersuchungen*, vol. i. pp. 198, 199, the argument in the case of the star being the *true* zenith distance, which is obtained by the formula  $\sec. ZS = \sec. QZ \cdot \sec. (PS - PQ)$ . The argument in the case of the compared object is the *apparent* zenith distance, which is deduced from the same formula, the apparent N.P.D. and hour-angle being first obtained by applying the corrections for refraction in N.P.D. and R.A. of the star (with signs changed) to its true N.P.D. and R.A., together with the measured differences of N.P.D. and R.A. affected only by refraction.

“The above calculations will be much facilitated by two tables, one containing the values of PQ, log. sec. QZ, and log.  $\frac{\tan QZ}{15}$  (to five figures) for every minute of hour-angle from 0<sup>h</sup> to 6<sup>h</sup>, which will be found to require interpolations only to first differences, and which is, in fact, merely an expansion of the table mentioned in the *Monthly Notices*, vol. viii. No. 9, p. 210. The other is a table for obtaining the factor A. It will save much trouble, and be sufficiently accurate to take account of the barometer and thermometer by the empirical formula given in the *Monthly Notice* above cited, viz. :

$$\log A = \log k + 0.015 B + 0.001 (100^\circ - T),$$

in which log k is log  $\alpha$  or log  $\alpha'$  of Bessel, according as the argument is the true or the apparent zenith distance, diminished by the constant 0.49572. Any error which the use of this formula induces, will very nearly disappear in the *differences* of the refractions. Thus the second table need merely consist of values of log  $\alpha - 0.49572$ , and log  $\alpha' - 0.49572$ ; and the most convenient argument is log. sec. ZS, the consecutive logs. differing by 0.01. This table would, therefore, very well range with the table of values of log.  $\alpha'' - 0.4957$ , required in the computation of differential refractions.”

Professor Mädler having expressed a wish that certain stars should be re-observed in the southern hemisphere, the President and Council forwarded the request to Mr. Maclear, with a recommendation to comply with it, if convenient. We have received from Mr. Maclear the reduced observations, and the results are published here as the readiest way of communicating with Professor Mädler.\*

\* A letter was sent to Professor Mädler, offering to procure for him the Catalogues of Johnson, Taylor, &c., but it probably never reached him.

## Mean Places of Southern Stars for January 1, 1847.

B.A.C.	R.A.	Mean R.A. h m s	Ann. Prec.	Obs. in N.P.D.	Mean N.P.D.	Ann. Prec.
88	26	0 17 37.76	+2.582	43	168° 6' 57.7	-19.996
483	12	1 29 30.38	2.226	20	148 55 18.4	18.545
681	20	2 4 15.25	2.201	17	141 34 36.2	17.179
1044	11	3 13 49.30	2.116	17	133 39 28.8	-13.301
2151	15	6 27 53.62	+1.734	21	135 11 49.6	+2.435
2262	13	6 46 43.42	-1.198	16	162 56 49.7	4.060
2721	10	8 0 24.83	+1.684	20	140 9 21.5	10.059
5719	22	16 52 20.82	5.881	20	155 31 27.3	+5.835
6248	13	18 16 45.19	5.172	31	147 36 31.1	-1.465
6804	15	19 43 11.16	6.232	20	159 9 23.0	8.727
7575	18	21 38 9.64	4.264	17	146 58 46.2	16.335
7656	18	21 51 36.75	4.182	22	147 24 37.9	16.990
7816	21	22 17 16.58	4.524	23	158 15 45.5	18.074
8080	17	23 4 30.58	3.459	21	140 26 56.7	19.470
8249	11	23 35 13.88	3.859	18	169 38 26.6	19.938
8260	18	23 38 25.10	+3.185	19	132 23 42.6	-19.966
3479	4	10 4 21.63	+1.700	6	154 45 42.1	+17.557
3481	4	10 4 26.70	+1.681	8	155 4 1.5	+17.559

Nos. 3479 and 3481 are not given in Mädler's list, but were observed on account of their proximity to the place assigned to No. 3482 of the B.A.C., which latter star *does not at present exist*.

Collecting from the various authorities the positions in R.A. and N.P.D., on which the place of 3482 depends, and bringing them up to January 1, 1847, by precession alone, we obtain

			R.A. h m s	N.P.D. ° ' "
Lacaille (4184)	...	...	10 3 27.4	154 51 30.9
Brisbane (2870)	{ 2 obs. by mural		10 4 18.1	3 obs. 154 51 44.2
	{ 3 do. by transit		10 4 19.5	
Rümker (196)	2 obs.		10 4 27.9	154 52

In the B.A.C. Rümker has been taken as the modern authority for R.A. and Brisbane for N.P.D.; the difference of 1<sup>m</sup> between the R.A.'s of Lacaille and Rümker being attributed to proper motion of the star. On referring to the *Catium Australe Stelliferum*, the star observed by Lacaille will be found re-ordered in Zone x. April 26, 1752, "in parte inferiore," the times of ingress and egress being respectively 9<sup>h</sup> 58<sup>m</sup> 6<sup>s</sup> and 10<sup>h</sup> 3<sup>m</sup> 20<sup>s</sup>. If 2<sup>m</sup> be added to the time of egress, the place of the star for 1750 (employing the Reduction Tables given in the Catalogue of 9766 stars) will become

	R.A. h m s	N.P.D. ° ' "
or brought up to 1847	10 1 42.2	154 35 49
	10 4 25.2	155 4 7

The place for 1847 of B.A.C. 3481, from the Cape observations given above, is 10<sup>h</sup> 4<sup>m</sup> 26<sup>s</sup>.7 N.P.D. 155° 4' 1".5. Thus the identity of Lacaille (4184) and B.A.C. 3481 is highly probable, and warrants the assumption of an error of 2<sup>m</sup> in the original observations of the former.

The R.A. of Rümker (196) agrees pretty closely with the observed place of B.A.C. 3481, and the star observed by Brisbane in R.A. is probably identical with B.A.C. 3479; but his N.P.D. differs from that of the latter star by about 6'. Rümker has no observation in N.P.D. of (196); he gives the position to the nearest minute only.

The Astronomer Royal gave a description of the gigantic telescope erected by the Earl of Rosse, at Birr Castle, which he visited and carefully examined this autumn. The mode of grinding and polishing the speculum, the mounting, &c. were fully described and illustrated by models, and the residual difficulties stated. He also exhibited models of Mr. Lassell's grinding and polishing machine, and of the mounted instrument, dome, &c. It was clearly shewn that, though pursuing different courses, the Earl of Rosse and Mr. Lassell had each attained almost *absolute perfection* in figuring and polishing their specula, and that the difficulties in mounting, &c. were gradually overcoming by Lord Rosse, while they were already nearly got rid of by Mr. Lassell in his comparatively small instrument.

Mr. Drew, who has lately built and furnished a very convenient observatory at Southampton, adopts a collimating telescope for getting rid of his error of collimation. To this latter telescope he has attached a wire micrometer, which supplies the object to be viewed by the transit. He also uses the wire micrometer to measure the intervals of his wires. The results are more readily obtained than by slow moving stars, and he conceives with at least equal accuracy. Specimens of the determination of the intervals by both methods are given, which agree very nearly.

The Beaufoy Clock, which is lent by the Society to Mr. Drew, has been cleaned and set up in his observatory. Some remarkable irregularities have occurred in its rate, and when the weight and bob are nearly at the same height, the clock has stopped. In the present arrangement of the weight, it passes in front of the bob and about half an inch distant. Motion is communicated by the bob to the weight, either by the medium of the air or the play of the frame. It has been proposed to hang the weight on one side, out of the way, and so close to the clock-case as to touch it, in order that any oscillation may be prevented.

Hind's changing star has been carefully observed by Mr. Bond at Cambridge, U.S. "The colour is a brilliant red, not surpassed in intensity by any other star. With power 1500 there is no indication of a planetary disc. It was of the 6th magnitude on May 25th, and at our last observation had diminished to the 7·8th. There are thirty small stars within 6' of it; and with one of these, of 15th magnitude, numerous observations of position and distance have been made at different times. The mean result is

1848·52                      Position  $212^{\circ} 8'$                       Distance  $116''\cdot 1$

The differences from the mean are irregular and clearly accidental.

Mr. Bond remarks, that in the vicinity of *Procyon* three stars are missing, all within a few minutes' distance, viz. a star of 8th magnitude, Smyth's *Celestial Cycle*, p. 182, and both components of a double star 7th magnitude in Bessel's Zone 52.

*Table to connect the Nomenclature of the A.S. Catalogue with that of the B.A. Catalogue.* By Mr. Woollgar.

"The Astronomical Society's Catalogue has been in use upwards of twenty years, and stars are frequently quoted from it by the ordinal numbers only. In the British Association Catalogue there is no express column of reference to the former Catalogue. That Mr. Baily did not appropriate one for that purpose probably arose from the knowledge that the numbers of Taylor's *second* Catalogue are identical with those of the A.S.C., though he has omitted to point out in the preface to the B.A.C. the applicability, in most cases, of such mode of connecting the two catalogues.

"Where the reference is to *any other* of Taylor's Catalogues, this resource fails; but in these cases the defect may be supplied by the following

*Supplemental Table of Connexion between the Numbers of the Astronomical Society's Catalogue and the British Association Catalogue.*

A.S.C.	B.A.C.	A.S.C.	B.A.C.	A.S.C.	B.A.C.	A.S.C.	B.A.C.	A.S.C.	B.A.C.
9	17	408	1150	805	2091	1101	3073	1835	5331
54	156	421	1181	808	2110	1102	3089	1848	5374
109	313	429	1206	811	2115	1105	3110	1864	5429
110	315	447	1253	856	2260	1124	3152	1890	5513
129	356	450	1259	891	2374	1137	3186	1910	5609
134	372	460	1284	895	2389	1160	3269	1968	5813
151	426	483	1331	909	2440	1167	3289	2010	5932
165	452	516	1391	926	2483	1178	3344	2149	6333
206	595	525	1413	927	2485	1196	3410	2157	6356
208	594	538	1438	950	2557	1199	3428	2195	6485
209	600	541	1444	965	2620	1309	3782	2205	6507
210	596	612	1614	971	2644	1314	3809	2216	6535
217	618	614	1611	982	2665	1395	4087	2241	6607
218	625	617	1618	992	2718	1409	4125	2285	6699
230	660	654	1701	997	2740	1410	4127	2308	6742
233	675	660	1717	1003	2755	1413	4140	2367	6907
246	737	663	1726	1007	2774	1416	4147	2476	7255
256	763	664	1725	1010	2785	1431	4197	2513	7370
263	781	689	1775	1025	2818	1485	4325	2642	7745
305	878	691	1782	1048	2913	1579	4623	2660	7781
313	901	692	1783	1052	2919	1592	4663	2717	7925
324	931	712	1841	1067	2950	1633	4767	2762	8053
351	989	725	1864	1071	2962	1642	4801	2774	8098
392	1126	737	1896	1078	2981	1657	4839	2844	8275
394	1125	766	1981	1084	3005	1667	4865	2871	8350

"A.S.C. 337 and 2460 [La Caille, 233 and 1692] are not in B.A.C.

"All the A.S.C. stars not contained in the above Table will be found in the B.A.C. under Taylor's name and with the signature ii. prefixed."



## ROYAL ASTRONOMICAL SOCIETY.

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CAPT. W. H. SMYTH, R.N., Vice-President, in the Chair.

*Transit of Mercury, Nov. 8-9, 1848.*

By the Rev. W. R. Dawes, at Cranbrook.

"My attention was directed principally to the appearance of the planet at its ingress, and to measurements of its diameter during the transit.

"The ingress was observed with my  $8\frac{1}{2}$ -foot achromatic, the aperture being limited to 4 inches, the eye-piece magnifying 87 times. So extremely undulating was the edge of the sun in general, that no advantage seemed to arise from an increase of power. Nothing remarkable was noticed till *Mercury* had advanced on the sun's disc to about three-quarters of its own diameter, when the cusps appeared much rounded off, giving a pear-shaped appearance to the planet. The *degree* of this deformity, however, *varied* with the steadiness and definition of the sun's edge, being *least* when the definition was *best*. A few seconds before the complete entrance of the planet, the sun's edge became much more steady, and the cusps sharper, though still occasionally a little broken towards their points by the undulations. At the instant of their junction the definition was pretty good, and they formed the finest conceivable line, *Mercury* appearing at the same time *perfectly round*.

"The impression upon my mind was, that the distortion of the planet arose entirely from the rounding off of the points of the cusps by the tremor and diffusion of the image. I have repeatedly observed precisely the same appearance at the ingress and egress of the shadow of a satellite of *Jupiter*, when the edge of the planet has been rather undulating and diffused.

"For the measurement of the diameter of *Mercury*, I had prepared several different instruments. The filar micrometer was applied to the  $8\frac{1}{2}$ -foot equatorially mounted achromatic, the clock motion being in use. A 5-foot achromatic by Dollond was furnished with one of his spherical crystal double-image micrometers, and mounted on a very stout floor-stand with an equatorial socket. An excellent Gregorian reflector, of 5 inches aperture and 20 inches focus (the large metal figured by Cuthbert), and furnished with its own divided object-glass heliometer, was also employed. And, lastly, a spherico-prismatic crystal double-image micrometer was

applied to the  $8\frac{1}{2}$ -foot equatoreal. Measurements were obtained with each of these instruments, but, from the excessive tremor which usually affected the image, the results were not very satisfactory.

With the  $8\frac{1}{2}$ -foot equatoreal and filar micrometer, power 163, aperture reduced to 2.84 inches,

Polar diameter of *Mercury* =  $9''.3694$ , six observations.

Same instrument and power, aperture 4.02 inches,

Polar diameter =  $9''.3890$ , six observations.

The mean of the two sets =  $9''.393$ .

Same telescope, and spherico-prismatic micrometer, power 184,

Polar diameter =  $8''.89$ , three observations.

With the 5-foot achromatic and the spherical micrometer, power 117,

Polar diameter, by four observations =  $9''.02$  } diff. =  $0''.34$   
 Equatoreal diameter, by two do. =  $9''.36$

With the heliometer on the 20-inch Gregorian, power 115,

Polar diameter, by four observations =  $8''.89$  } diff. =  $0''.31$   
 Equatoreal diameter, by ten do. =  $9''.20$

"No difference is recognised in the *Nautical Almanac* between the polar and equatoreal diameters of this planet; yet my observations, both with the 5-foot achromatic and the Gregorian, shew a perceptible difference, and nearly to the same amount. And it was noticed with each of the double-image micrometers that a satisfactory measure of the equatoreal diameter was always perceptibly too large for the polar diameter, the images appearing slightly separated; and that, on the contrary, with a good measure of the polar diameter, the images overlapped when placed in the direction of the equator. The change was repeatedly made from one to the other, and always with the same result. The compression would thus appear to be about  $\frac{1}{25}$ .

"It will be remarked that no sensible difference was produced in the apparent diameter by varying the aperture from 4.02 inches to 2.84 inches. The same darkening glass was employed with both apertures; and therefore, though the *telescopic* irradiation would be *least* with the *larger* aperture, yet, the image being brighter with that aperture, the *ocular* irradiation would be *greater*. Probably, therefore, the two effects might counteract each other.

"The measurements, though few, were taken with extreme care, each of them having been repeatedly examined under the best views before it was read off."

By Mr. T. Dell, at Dr. Lee's Observatory, Hartwell.

"The time was taken from the transit-clock, the error of which was well known from observations on the 7th and 8th. The first contact was not noted with any degree of certainty: the interior contact was well observed.

Interior contact  $14^h 18^m 55^s.3$  Sid. Time, or  $23^h 3^m 57^s$  M. Time at Hartwell.

"My attention was directed by the Rev. Mr. Reade to a phenomenon described by the late Professor Moll (*Mem. Ast. Soc.* vol. vi. p. 116), a recurrence of which we all observed,—Mr. Reade and his assistant, with a Gregorian telescope, at Stone, and again with me here. This is a considerable greyish spot on the disc of *Mercury*, very indefinite, but gradually shading off from the brightest point in the centre to the blackness of the rest of the planet. I have attempted to give some idea of this appearance in the drawing annexed, as seen with a power of 240; with a less power we could not distinguish it."

By the Rev. Mr. Reade, at his Observatory, Stone.

Mr. Reade has sent a drawing of the grey spot observed in *Mercury*, which agrees with Mr. Dell's. The observations consist of a numerous series of angles measured from *Mercury* to spots on the sun, from which M. Fazell has made an elaborate chart of the path of *Mercury* over the sun's disc.

By Mr. Hartnup, at the Observatory, Liverpool.

Equatoreal,  $8\frac{1}{2}$ -inch achromatic; power, 134.

Internal contact  $23^{\text{h}} 6^{\text{m}} 54^{\text{s}}.4$  Greenwich Mean Time.

"The instant is noted at which the sun's light was first seen to surround the planet completely."

## NEPTUNE.

LIVERPOOL.		Equatoreal.		(Mr. Hartnup.)	
1848.	Greenwich M.T.	R.A.	N.P.D.	Obs <sup>d</sup> —Cal <sup>d</sup>	
	h m s	h m s	° ' "	R.A.	N.P.D.
Oct. 25	10 11 42.9	22 8 52.66	102 8 28.8	—1.62	+ 7.4
27	9 36 22.7	8 48.74	8 48.6	1.72	7.5
29	8 30 54.9	8 45.76	9 6.5	1.37	8.4
Nov. 4	6 22 12.0	8 38.63	9 40.7	1.43	7.8
6	7 58 45.8	8 37.12	9 46.3	1.52	7.2
7	8 50 53.7	8 36.95	9 50.5	1.20	9.4
9	9 39 43.8	8 35.93	9 50.7	1.62	8.0
10	5 43 48.6	5 36.02	9 50.9	1.44	8.3
21	7 58 42.4	8 43.36	9 1.8	1.63	9.5
24	7 5 54.5	22 8 48.24	102 8 34.9	—1.51	+ 11.3

The observations have been corrected for refraction and parallax, and compared with Mr. Adams' Ephemeris.

The star of comparison, for all the observations, is B.A.C. 7722.

The mean place for Jan. 1, 1848, according to the Catalogue, is

$$\text{R.A.} = 22^{\text{h}} 2^{\text{m}} 29^{\text{s}}.78 \quad \text{N.P.D.} = 102^{\circ} 18' 34''.56$$

## IRIS.

Approximate Ephemeris.\* By Mr. Hind.

		Greenwich Mean Noon.			Log. $\Delta$
		R.A.	Decl.		
1848.		<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>		
Nov. 23	10	10 4'3	+6 39 56		0.29729
26		12 48'6	6 14 46		.29080
29		15 21'1	5 50 25		.28420
Dec. 2		17 41'0	5 26 54		.27749
5		19 48'1	5 4 20		.27071
8		21 41'8	4 42 44		.26386
11		23 21'7	4 22 12		.25695
14		24 47'3	4 2 48		.25001
17		25 58'1	3 44 39		.24305
20		26 53'5	3 27 47		.23609
23		27 33'1	3 12 19		.22918
26		27 56'5	2 58 19		.22234
29		28 3'5	2 45 51		.21561
1849.					
Jan. 1		27 53'7	2 35 0		.20902
4		27 27'3	2 25 50		.20262
7		26 44'1	2 18 22		.19645
10		25 44'3	2 12 43		.19056
13		24 27'8	2 8 53		.18499
16		22 55'4	2 6 55		.17980
19		21 7'5	2 6 50		.17503
22		19 4'9	2 8 37		.17074
25		16 48'9	2 12 14		.16698
28		14 19'9	2 17 41		.16381
31	10	11 38'4	+2 24 56	10	0.16129

\* From the elements in the *Monthly Notice*, June 1848, without perturbations.

## FLORA.

## HAMBURG.

(MM. C. &amp; G. Rümker.)

1848.	Hamburg M.T.	R.A.	* Decl.	
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>	
Jan. 26	6 18 24'6	63 34 56'2	+18 11 13'7	Equator.
	7 53 30'8	35 30'1	28'2	11 52'6 Mer. Cir.
27	7 50 10'6	63 44 27'1	25'5	18 18 6'0 —
28	7 46 52'4	63 53 55'5	52'6	18 24 15'9 —
29	7 43 37'3	64 4 8'3	10'5	18 30 28'1 —
Feb. 4	7 18 16'0	65 13 15'4		19 7 38'0 Equator.
10	9 46 26'1	66 39 54'7		19 45 20'5 —
11	8 6 33'5	66 54 33'4		19 51 1'8 —
12	7 0 54'3	67 9 38'4		19 56 53'9 Mer. Cir.
15	10 30 48'0	68 2 20'7		20 15 55'5 Equator.
16	6 49 39'9	68 17 4'2	0'7	20 20 54'8 Mer. Cir.
29	8 42 48'0	72 34 37'0		21 34 42'4 Equator.
March 2	7 37 31'0	73 17 21'9	+21 44 7'4	—

\* The column below contains the seconds of R.A. observed by Mr. G. Rümker with the transit.

# PETERSEN'S SECOND COMET.

## Observations.

CAMBRIDGE. Northumberland Equatoreal. (Professor Challis.)

	Greenwich M.T.			R.A.			Log $\frac{p}{P}$	N.P.D.			Log $\frac{q}{P}$	No. of Comps.	Star.
1848.	h	m	s	h	m	s		°	'	"			
Nov. 4	11	31	34.9	18	59	33.90	8.851	32	14	36.3	-9.791	2	<i>a</i>
		41	7.5			33.63	8.842			43.2	9.804	12	<i>b</i>
	8	9	22 40.6	19	17	45.37	8.845	35	8	47.3	9.558	6	<i>c</i>
	9	7	56 18.5	22	8	22	8.768	35	54	5.0	9.281	8	<i>d</i>
	10	9	45 18.2	27	10	23	8.832	36	47	34.6	9.620	6	<i>e</i>
	13	6	24 45.4	40	24	47	8.567	39	18	56.5	9.035	1	<i>f</i>
			43 52.6			27.59	8.609			19 36.2	9.112	7	<i>g</i>
	14	7	57 51.3	45	19	94	8.730	40	18	25.3	9.417	6	<i>h</i>
	15	7	18 8.2	19	49	46.29	8.656	41	14	53.0	9.306	8	<i>i</i>
	21	8	4 4.9	20	17	1.17	8.670	47	38	0.1	9.556	8	<i>k</i>
	24	6	50 45.0	20	30	0.08	8.508	51	6	35.9	9.489	6	<i>l</i>
Dec. 2	8	59	20.2	21	4	5.39	8.644	61	36	20.3	9.776	3	<i>m</i>
	4	7	52 38.7	11	57	51	8.563	64	17	33.6	9.741	6	<i>n</i>
	6	7	19 7.6	21	19	45.79	8.496	67	2	42.8	-9.744	4	<i>o</i>

"The corrections to be applied for parallax in time and arc are represented by  $p$  and  $q$ ;  $P$  is the equatoreal horizontal parallax, or  $\frac{8''.5776}{\Delta}$ . The following are the authorities for the places of the stars:—

<i>a</i>	B.A.C. 6500	<i>i</i>	Arg. Z. 134, 35
<i>c</i>	Groombridge 2839	<i>k</i>	Groombridge 3157
<i>d</i>	— 2855	<i>l</i>	B.A.C. 7167
<i>e</i>	Arg. Z. 14, 53	<i>m</i>	H. C. $\left\{ \begin{array}{l} 41060 \\ 41062 \end{array} \right\}$
<i>f</i>	B.A.C. 6763	<i>n</i>	H. C. 41503
<i>h</i>	Arg. Z. 21, 99	<i>o</i>	B.A.C. 7474

The assumed apparent place, Nov. 13, of the star *g*, viz. R.A. =  $19^h 39^m 42^s.28$ , N.P.D. =  $39^\circ 17' 10''.5$ , was determined by one comparison by the equatoreal with B.A.C. 6763; and the mean place of the star *b* was found by meridian observations to be as follows:—

1848, Jan. 0. R.A. =  $18^h 58^m 41^s.00$ ; N.P.D. =  $32^\circ 12' 31''.6$ .

HAMBURG. Equatoreal. (M. C. Rümker.)

	Hamburg M.T.			R.A.			Decl.		
1848.	h	m	s	h	m	s	°	'	"
Nov. 7	16	34	44.4	19	14	22.20	+55	25	16.1
	8	16	36 43.4		19	3.73		54	38 3.5
	14	6	20 3.4		44	52.42		49	47 1.2
	15	5	57 6.5		19	49 23.55		48	50 9.3
	19	5	45 30.9		20	7 31.71		44	43 40.2
	20	5	45 16.3		12	1.89		43	37 44.8
	21	5	52 58.7		16	30.96		42	30 5.3
	22	7	54 12.9		21	18.58		41	15 15.1
	23	7	5 13.8		25	33.40		40	6 59.6
	25	7	29 33.3		20	34 21.16		+37	39 43.8

## HAVERHILL.

(Mr. W. W. Boreham

Greenwich M.T.				R.A.			N.P.D.				Star of Com							
1848.	h	m	s	h	m	s	°	'	"	°	'	"						
Nov.	19	7	47	40	20	7	59.58	+0°047	×	P	45	24	12.0	-0°30	×	P	Groom.	31
	24	6	58	18	30	2	81	028			51	5	55.1	32			B.A.C.	71
	28	6	22	58	20	47	3.00	026			56	7	54.6	36			H.C.	403
Dec.	2	7	15	37	21	3	42.65	033			61	31	50.8	29			—	411
	4	6	36	18	11	43	60	026			64	13	9.6	49			—	414
	5	6	34	45	15	40	30	026			65	36	6.8	51			—	416
	6	6	50	30	19	41	37	028			67	1	0.6	54			B.A.C.	74
	9	7	43	13	31	22	06	034			71	15	32.7	63			—	75
	10	7	46	39	35	11	36	034			72	39	54.8	64			H.C.	423
	15	7	35	15	21	53	15.30	+0°032			79	32	7.6	-0.68			Weisse xxi,	12

"P is the horizontal parallax of the comet in seconds of space. The observations were made with a bar-micrometer. There is probably an error of 1° in H. C. 42393, the N.P. should be 73° instead of 72°."

## CAMBRIDGE, U.S.\*

## Equatoreal.

(Mr. W. C. Bond.)

1848.	Cambridge M.T.			R.A.			Decl.			
	h	m	s	h	m	s	°	'	"	
Nov. 25	6	55	41	20	35	11.2	+ 37	24	15	with Circles and <i>Cygni</i>
27	6	58	34	43	45	8	34	52	24.1	Lalande, 40277
29	6	55	53	20	47	57.35	+ 33	34	54.5	

On Nov. 25, at 6<sup>h</sup> 56<sup>m</sup> 41<sup>s</sup>, comet follows a star of 9 mag. in 25<sup>m</sup> 6, and is 2' 25" 1 to the north of it.

Approx. place of Star, R.A. = 20<sup>h</sup> 34<sup>m</sup> 45<sup>s</sup> Decl. +37° 22'

"The comet has a nucleus resembling a star of 9.10 magnitude, so well defined that the motion became sensible in the course of one or two minutes. The coma radiates, and is about 5' in diameter. The tail extends about 20' opposite the sun. The places are referred to the mean equinox, Jan. 1, 1848."

## Elements.

By M. d'Arrest.

Time of Perihelion Passage, 1849, Jan. 19.39335, Berlin M.T.

Long. Perihelion..... 63° 16' 1.9 } Mean Eq<sup>x</sup>.

— Node..... 215 13 43.4 } 1849°

i ..... 85 2 11.5

Log. q..... 9.9820574. Motion direct.

By MM. Petersen and Sonntag.

Time of Perihelion Passage, 1849, Jan. 19.39136, Berlin M.T.

Long. Perihelion..... 63° 12' 34.7 } Mean Eq<sup>x</sup>.

— Node..... 215 12 0.0 } 1849, Jan. 1.

i ..... 85 3 38.9

Log. q ..... 9.9822562. Motion direct.

"From the Altona observations of Oct. 26, Nov. 10, and Nov. 25."

\* The comet was *discovered* on the evening of Nov. 25 by Mr. G. P. Bond.

By Mr. N. Pogson.

Time of Perihelion Passage, 1849, Jan. 19<sup>h</sup> 37<sup>m</sup> 44<sup>s</sup>, Greenwich M.T.

Long. Perihelion.....	63° 11' 49".6	} Mean Eq <sup>s</sup> .
— Node.....	215° 10' 57".7	
i .....	85° 4' 19".54	
Log. q .....	9.9822469.	Motion direct.

"From Dr. Petersen's observations of Oct. 26, and Mr. Hind's on Nov. 4 and 12. All the small corrections have been taken into account."

*Ephemeris.* By MM. Petersen and Sonntag, from their Elements.

For Six Hours Berlin Mean Time.

	R.A.	Hourly Variation.	Decl.	Hourly Variation.	Log. Dist <sup>s</sup> from Earth.	Log. Dist <sup>s</sup> from Sun.
1848.	° ' "	"	° ' "	"		
Nov. 30	313 49 0.1	+155.49	+31 18 15.1	—200.18	9.97844	0.10916
Dec. 1	314 50 54.6	154.05	29 57 43.5	202.42	.97652	.10551
2	315 52 14.2	152.58	28 36 21.5	204.37	.97486	.10186
3	316 52 58.3	151.09	27 14 15.7	206.05	.97348	.09821
4	317 53 6.3	149.62	25 51 33.5	207.42	.97238	.09457
5	318 52 38.1	148.06	24 28 21.5	208.52	.97156	.09094
6	319 51 32.9	146.51	23 4 47.3	209.29	.97101	.08731
7	320 49 50.3	144.95	21 40 57.9	209.77	.97074	.08369
8	321 47 30.5	143.39	20 17 1.1	209.92	.97075	.08009
9	322 44 33.1	141.82	18 53 4.0	209.78	.97104	.07650
10	323 40 58.1	140.25	17 29 13.8	209.34	.97161	.07293
11	324 36 45.3	138.68	16 5 37.8	208.61	.97244	.06937
12	325 31 54.8	137.11	14 42 22.9	207.58	.97354	.06583
13	326 26 26.6	135.53	13 19 35.7	206.30	.97490	.06233
14	327 20 20.8	133.97	11 57 22.7	204.75	.97651	.05885
15	328 13 38.0	132.43	10 35 49.6	202.96	.97835	.05540
16	329 6 17.7	130.87	9 15 2.4	200.94	.98042	.05198
17	329 58 20.5	129.35	7 55 6.1	198.72	.98272	.04860
18	330 49 46.6	127.83	6 36 5.2	196.32	.98522	.04526
19	331 40 36.5	126.32	5 18 4.5	193.72	.98792	.04194
20	332 30 50.2	124.82	4 1 7.5	190.99	.99081	.03869
21	333 20 28.1	123.34	2 45 18.0	188.13	.99387	.03550
22	334 9 30.6	121.87	1 30 38.4	185.15	9.99709	.03236
23	334 57 58.3	120.43	+ 0 17 11.7	182.07	0.00046	.02926
24	335 45 51.3	118.99	— 0 55 0.5	178.93	.00397	.02623
25	336 33 9.9	117.56	2 5 56.1	175.71	.00760	.02326
26	337 19 54.9	116.17	3 15 34.4	172.47	.01134	.02038
27	338 6 6.3	114.78	4 23 54.0	169.18	.01518	.01757
28	338 51 44.8	113.43	5 30 54.9	165.89	.01910	.01483
29	339 36 50.8	112.10	6 36 36.6	162.59	.02310	.01218
30	340 21 25.2	110.82	7 40 59.4	159.31	.02716	.00960
31	341 5 27.5	109.55	8 44 3.3	156.02	.03128	.00712
1849.						
Jan. 1	341 48 58.6	+108.30	— 9 45 48.5	—152.77	0.03544	0.00473

*Ephemeris for Berlin Mean Noon.*

	R.A.	Dec.	Log. $\Delta$	Log. $r$
1849.				
Jan. 0	340 54'5	— 8 28'4	0'03025	0'00774
10	347 49'3	17 58'0	07256	9'98855
20	354 4'2	25 28'9	11169	98228
30	359 55'1	31 41'2	14426	9'99026
Feb. 9	5 41'2	36 53'0	16884	0'01080
19	11 44'2	41 21'5	18584	04022
March 1	18 27'7	45 19'6	19641	07460
11	26 15'7	48 55'1	20216	11086
21	35 34'4	52 9'0	20498	14705
31	46 48'0	54 54'2	20697	18206
April 10	60 7'0	56 54'5	21039	21536
20	75 9'6	—57 48'8	0'21743	0'24676

## ENCKE'S COMET.

The following observation was made at Cambridge, U. S., with the circles of the equatoreal, corrected by  $\alpha^2$  *Libræ* :—

Cambridge M.T.

1848 Nov. 25 18<sup>h</sup> 5<sup>m</sup> 20<sup>s</sup> R.A. = 14<sup>h</sup> 52<sup>m</sup> 59<sup>s</sup>.4 N.P.D. 106° 44' 49"

The observation is corrected for refraction and instrumental error only, and the place is referred to the mean equinox, Jan. 1, 1848.

## LIVERPOOL.

## Equatoreal.

(Mr. Hartnup.)

	Greenwich M.T.	R.A.	Corr. Eph.	N.P.D.	Corr. Eph.	No. of Comps.
1848.	h m s	h m s		° ' "		
Oct. 10	15 15 59	7 57 13'15	+ 36'80	36 56 31'0	+ 2 18'2	9 a
18	17 41 46	10 26 57'01	29'98	44 52 2'5	4 38'6	2 b
22	17 1 4	11 24 59'43	9'79	53 3 6'7	5 12'5	6 c
23	17 33 7	11 37 30'42	8'19	55 21 47'9	4 58'7	5 B.A.C. 3965
25	17 44 23	11 59 27'86	+ 6'39	59 58 11'7	+ 4 48'1	5 d

"For the observations of Encke's comet, four thick wires were placed so as to form a small square in the centre of the field. The hour-circle was set going nearly to sidereal time, the star and comet were brought alternately into the centre of the square, the time noted, and the hour-circle and declination-circle read off. The observations were made under the disadvantage of little previous experience, and the management of the clock was not at that time thoroughly acquired."

"The observations are corrected for parallax and refraction, and compared with the ephemeris published by the Superintendent of the *Nautical Almanac*. The corrections noted must be applied to the ephemeris to produce the observed places."

"The place of B.A.C. 3965, is taken from that catalogue. The mean places of the other stars are :—

Epoch, Jan. 1, 1848.						*Compared by the Instru-	
R.A.				N.P.D.		ment with	
	<sup>h</sup>	<sup>m</sup>	<sup>s</sup>	<sup>°</sup>	<sup>'</sup>	<sup>"</sup>	
<i>a</i>	7	51	48.08	36	49	32.2	B.A.C. 2967      2 Comparisons.
<i>b</i>	10	23	24.35	45	2	23.9	—      3515      1      —
<i>c</i>	11	24	4.89	60	54	48.6	—      3856, 3965
<i>d</i>	12	2	44.82	60	5	9.7	—      4147      2      —

### Description of a Machine for Polishing Specula.

By Mr. Lassell.

"The twelfth volume of the *Memoirs of the Royal Astronomical Society* contains a description of a Newtonian Reflecting Telescope, of 9 inches aperture and 112 inches focus, equatorially mounted in a revolving dome of  $14\frac{1}{2}$  feet diameter.

"Several years' experience in the use of this instrument so well convinced me of its general efficiency, and especially of the convenience and stability of its mounting, that I determined, two or three years ago, to carry out precisely the same principle on a much larger scale.

"With a view of informing myself what degree of perfection is attainable in figuring surfaces of larger mirrors than can be wrought by hand, and also of ascertaining the proportion of aperture to focus which it would be most desirable to adopt, I visited Birr Castle; and, by the kindness of the Earl of Rosse, enjoyed the opportunity of two nights' observations with the 3-foot telescope erected by his lordship.

"I was also favoured with an examination of the whole of the machinery employed in grinding and polishing the great speculum; and I returned so well satisfied with all I had seen, that I very shortly resolved to cast a speculum of 2 feet diameter and 20 feet focus.

"The mode of casting the large speculum which I employed involved the principle, discovered, I believe, and first published, by Lord Rosse, of casting the speculum on what is technically called a *chill*, i.e. an iron base, slightly warmed, which causes the speculum to cool upwards in horizontal strata.

"Principally, however, from the difficulty of forming it, I did not employ a base constructed with iron hoops placed edgewise, and turned to the gauge, as Lord Rosse recommends, but, instead of it, a *disk* of cast iron, with its upper surface convex, according to the required radius of curvature, and a rebate formed on the edge of its upper surface, which, receiving a stout iron hoop equal in breadth to the thickness of the speculum, formed an iron mould, and dispensed altogether with the use of sand in the casting. The disk does not require to be *turned*, but if cast from a well-made

\* The partial results agree as well as those obtained by the best meridian instruments.

wooden pattern will be sufficiently true ; neither do I think turning the hoop essential, though it might be well to turn the inside surface and the edges, if the means of doing so were at hand.

"As it is necessary that the pouring should be pretty quick, in order that there may not be time for the base to solidify any portion of the metal before it is completely covered, I inclined the base a little, pouring on the lowest side, in order that the fluid might rise in one compact wave ; and when the disk was nearly covered, it was restored to a truly horizontal position, and the pouring continued, until the mould was sufficiently filled, namely, to the depth of about two inches and three quarters. The hoop was about three inches broad, and having been turned parallel, the mould was in the first instance placed horizontal, by a spirit-level being placed upon its edge. The inclination was produced by the application of a lever, which, when withdrawn, restored the base to its horizontal position, and ensured the equable thickness of the speculum at every part of its circumference."

Mr. Lassell then describes the very ingenious method which he adopted to procure the requisite quantity of metal in the proper state, and his mode of ascertaining that the dose of tin was sufficient. The final proportion which he used is 32 lbs. of copper to 15.09 lbs. of grain tin, and 18 lbs. of white arsenic were stirred up with 438 lbs. of the melted mixed metal.

"The speculum was ground and polished on a machine almost precisely the same as that described by Lord Rosse in his lordship's very interesting paper, published in the second part of the *Phil. Trans.* for 1840.

"I found, however, the grinding process much facilitated by interposing a piece of sheet-lead, about a tenth or twelfth of an inch thick, between the speculum and the iron grinding-tool. This saved the rapid wearing down of the tool and also cut the metal much faster, as the softness of the lead suffered the particles of emery to imbed themselves into it, and thus to form a very keen grinding surface. When the lead, fully charged with the emery, had become smooth, it was exchanged for a fresh piece. When an entire surface had been obtained upon the speculum, the smoothing and perfecting of the surface previous to polishing was produced by the iron tool and the finest washed emery.

"The speculum was polished many times on the same machine, following as nearly as practicable the directions given by Lord Rosse ; but, after several months' trial, I did not succeed in obtaining a figure which satisfied me, the best I got being very inferior to the surfaces I had obtained by hand on specula of various sizes, up to nine inches diameter. In despair of success by this process, I ultimately contrived a machine, in which I endeavoured to represent as closely as possible the evolutions of the hand, by which I had been accustomed to produce very satisfactory surfaces on smaller specula."

The machine invented by Mr. Lassell, and constructed by Mr. Nasmyth, for figuring and polishing specula, cannot be made intel-

ligible without figures.\* The speculum rests with its face uppermost in a horizontal position, and is carried slowly round by a vertical axis. The polisher rests, with its grinding and polishing surface, upon the speculum, and is moved by a pin which fits loosely into a hole in the centre, at the back of the polisher. The motion of the polisher is that of the driving-pin.

Now this, by a very ingenious and very compact mechanism, receives a compound motion which may be thus imagined. Conceive a circular motion given to a point round the centre of the speculum, and then conceive that the driving-pin has a circular motion round this point. The curve is an *epitrochoid*, and the adjustments of the mechanism enable the workman to give any radius to either circular motion, from 0 up to a certain number of inches. The proportions of these radii, in order to give a parabolic figure, are determined experimentally, in which the relation of aperture to focal length must be considered. The size of the polisher, and even the hardness of the pitch, must also be proportioned to the figure and aperture required. Mr. Lassell finds no difficulty in getting a true parabolic figure when the aperture is one-eighth of the focal length.† The speculum, while grinding and polishing, is supported in the same way as it is in the tube when in use. The principle of this mode of support is mentioned by Lord Rosse, *Philosophical Transactions*, 1840, p. 524.

"The polisher should possess as much stiffness as is compatible with the requisite lightness, and I have found these qualities best combined by making it of white American deal, in two strata, well united by glue and a few screws, with the direction of the grain at right angles, the wood well seasoned, and, if possible, cut out of the same board. The polisher for the 2-foot speculum is made out of  $1\frac{1}{2}$  inch board, and has, for symmetry, both the upper and under surfaces convex, to fit the speculum. It is about 2 inches thick at the circumference,  $20\frac{1}{2}$  inches diameter, and weighs about 12 lbs. with the pitch surface upon it."

Mr. Lassell then enters very minutely into the mode of coating the polisher with pitch evenly and to a proper thickness, of dividing the surface into equal squares, and the various manipulations which are required to produce a perfect result. The grinding powder is known as *rouge*, and the best quality may be had from Mr. Fox of Saffron Hill.

\* A model to half the true size, and the drawing by Mr. Nasmyth, may be seen at the Society's apartments. A model of Lord Rosse's engine, and of the mounting, &c. of the 6-foot reflector at Birr Castle, may also be seen. These were made by Mr. Airy, and presented by him to the Society. Mr. Williams will explain the action and details of all the models to any fellow who wishes for information.

† Mr. Lassell has given so full an account of all his processes that we conceive any person of ordinary intelligence would be able to execute them, but they do not admit of compression, and extend beyond the limits of a *Monthly Notice*. It ought to be mentioned that the Earl of Rosse and Mr. Lassell have at all times freely communicated the steps of progress as soon as these became evident to themselves.

"The whole time occupied in obtaining the requisite lustre varies from about one hour to three, and it ought to be steadily advancing throughout.

"A good idea may be formed of the quality of the operation as it proceeds by watching the motion of the tool. It should be regular and uniform, without any apparent labouring or inequality of speed, and the spontaneous motion which the tool has upon the pin as a centre should be slow and regular. No firm adhesion is ever to be allowed between the tool and speculum: this will take place if a due and regular supply of water be not afforded.

"A second application of powder will rarely be required, and never in any quantity, but many applications of water probably will, and the more rapidly the polish is advancing the more frequently will water be required. It is best applied through a hole in the back of the polisher as near the centre as is convenient, which may perhaps be at about the distance of one-third of the radius. But care should be taken not to give the water in excess. The speculum must never be *dry*, but there must be no superfluous water. It is very conveniently applied with a flat camel's-hair brush, half or three-quarters of an inch broad; but as much as the brush would take up would generally be too much for one application. Towards the end, the water should be added more sparingly, and if needful more frequently, going as near to dryness as may be but *never reaching it*.

"The lustre in this state of the process advances most rapidly. If the process has gone on well the powder will have become almost black at the close. The machine having been stopped, the tool is to be carefully taken off by a sliding motion, and the speculum may then be cleaned with a soft linen cloth or leather; or it may be washed with a soft sponge and water, and then dried, and ultimately rubbed lightly with some very soft wash-leather. If the polishing has apparently wrought smoothly, and the aspect of the tool when taken off, both during the process and at its close, is everywhere of even texture when viewed by an oblique light, the speculum will most likely have a *uniform* curve of some description, whether parabolic or not, for it is a characteristic quality of this machine generally to produce a uniform curve. The quality of the curve is best examined by placing the mirror in its tube, and, by means of diaphragms, exposing separate portions of the mirror of equal area from the centre to the circumference."

"I have been accustomed to produce by hand surfaces of, I believe, great excellence, on various sized specula up to nine inches diameter, of which I may instance my 9-foot equatoreal, which enabled me to discover independently (for I did not previously know of its existence) the sixth star in the trapezium of *Orion*, and with which also the observations of a second division of the ring of *Saturn* were made, as described in the *Astronomical Notices*, vol. vi. p. 11. Such surfaces as these were, however, produced with some degree of anxiety, much manual labour, and perhaps some admixture of accident, especially in the union of a perfectly para-

bolic curve with regularity of surface. The superiority of the machine in these respects is so striking as almost to put comparison out of the question.

"If driven by a steam-engine the manual labour is of course annihilated. The control over the machine, by the setting of the cranks, is such, at least with all foci not less than eight diameters of the speculum, that the curve can be changed almost at pleasure from the spherical side to the hyperbolic side of the parabola, and *vice versa*; the alterations of the curve being, *ceteris paribus*, almost exactly commensurate with the adjustments of the cranks. In fact, one of the most anxious and laborious operations is, by this machine, converted into an intensely interesting amusement. With moderate care and a little experience a *bad* figure never need to be feared, though it may require two or three successive trials to satisfy the fastidiousness of a cultivated and long-practised eye. The lustre of polish transcends even my best efforts by hand, and is the easiest quality of all to obtain; and however erroneous the figure may be after any unsuccessful effort, the proper curve may be recovered without resorting to the grinder, or indeed materially impairing the polish—at least, I have not found it needful, even when the difference of foci of the central and exterior portions of a mirror has amounted to fifteen hundredths of an inch. In 3 or 3½ hours by the polisher alone, it is possible to annihilate an error even as enormous as this. I have a strong persuasion that this machine might prove eminently serviceable in working the curves of object-glasses of large dimensions, though of this I have no experience."

Mr. Lassell then briefly describes the mounting of the telescope, the form, weight, and dimensions of its component parts, and the covering dome. They are in *principle* almost the same as were used on a smaller scale in his 9-foot Newtonian. There is a very good model of the dome and mounting, presented by Mr. Lassell, at the apartments of the Society.

"To afford some notion of the degree of facility attained in the management of so large a dome and telescope, I may mention, that with an assistant I can, without hurry, place an object, invisible to the naked eye, within the field of the telescope in nine or ten minutes from leaving my house. This includes opening the dome, uncovering the large speculum, attaching the eye-piece, setting from the catalogue for the object, and turning the dome to the required azimuth. Without an assistant, I should require three or four minutes longer, which would be principally occupied in opening the shutters of the dome."

"One of the greatest difficulties I have encountered in supporting the speculum in its various positions equably, is to avoid the effects of the friction of its edge under considerable changes of altitude of the telescope."

"It is obvious, that when the altitude is low, the principal part of the weight of the speculum must be borne upon its edge, and the supporting plates being thus in a great measure relieved from the pressure of the speculum, must, by their elasticity, tend to distort

the metal by pressure at its back; and when the telescope is moved towards the zenith, the plates yield again by the weight of the speculum, while the lower edge, still in hard contact at the points of support, is unduly borne up there, and the equilibrium is destroyed. To remedy this evil I have slung the speculum in a hoop of thin iron, equal in length to half its circumference, the ends of the hoop being attached to swivels fixed in each of the two horizontal brackets, and the lower part of the hoop being thus quite at liberty to rise and fall with the plates.

"This has nearly, if not entirely, removed all perceptible distortion: yet in some positions, and under some circumstances, vestiges of it are to be perceived. I have devised a plan of supporting the metal laterally by an equal tension on the several points of support, and think it may probably be useful; but I have not yet had leisure to carry it into effect.

"Instead of a plane speculum I usually employ a prism, which transmits a pencil two inches in diameter, made for me by Messrs. Merz and Son, of Munich. I am persuaded, from repeated experiments, that the prism has an obvious advantage in light over a speculum, and the material is so fine, and the surfaces so exquisitely wrought, that no perceptible injury of the image exists. The only care necessary in the use of the prism is to preserve it from dew, which it is extremely liable to collect; this I have remedied by having a chamber made in the mounting of the prism, which receives a cube of cast iron enveloped in thick *felt*: this, being moderately warmed and placed in the chamber, effectually prevents the deposition of dew for at least some hours, while the extremely slow radiation through the felt does not produce any sensible disturbance in the formation of the image. The prism is rather small, for though it transmits the entire pencil, there is scarcely any thing to spare, and had it been easy to obtain a sufficiently good one half an inch larger, I should have procured it."

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*A short Notice of the Equatoreal of the Liverpool Observatory.*  
By Mr. Hartnup.

As the Astronomer Royal will probably give some account of this instrument, which has been constructed on his recommendation and entirely under his superintendence, Mr. Hartnup states, in a few words, that it is of the English construction; that is, the telescope is a transit supported at each end, between two long supports which form the polar axis. The telescope is by Merz of Munich,  $8\frac{1}{2}$  inches in aperture, and 12 feet focal length. The circle and declination-circle are each 4 feet in diameter, divided by Mr. Simms upon his "self-acting circular dividing engine."\* The

\* Described in Vol. xv. of the *Memoirs*. The new altitude and azimuth instrument at Greenwich, which was divided on the same engine, is considered by Mr. Airy to be exceedingly well divided.

hour-circle revolves independently of the instrument, and is carried by clock-work, the moving power of which is a water-mill, regulated by "Siemen's *Chronometric Governor*." This is so successfully applied, that the rate of the hour-circle is not sensibly altered by clamping the polar axis to it. When the hour-circle is properly adjusted, the instrument reads off right ascensions at once.\* The polar axis, which is of wrought iron-plate, is very massive and stiff. The weight of the whole instrument is between 70 and 80 cwt. This keeps all steady, even in very hard gales. The instrument is abundantly supplied with eye-pieces and micrometers. The stiff frame and large circles were evidently designed by Mr. Airy to supply a peculiar power to the instrument. In ordinary mountings, great accuracy is not to be expected when the star of reference is more than a few minutes distant from the object compared. The screw of the micrometer is not to be relied upon for larger spaces, and the circles, though sufficient for finding and identifying, are seldom intended for accurate measures. Stars of comparison can, indeed, generally be found which are contained in some of the special and extended catalogues, but such stars can only be considered to be roughly known, and in many cases fail altogether. The Liverpool equatoreal is intended to measure *by its circles* intervals of a few degrees, with as much accuracy as the average stars of our extensive catalogues possess, and thus to give excellent places by reference to well-known stars.

Mr. Hartnup has made some observations to test the powers of his equatoreal in this respect. The observations of  $\gamma$ ,  $\alpha$ ,  $\beta$  *Aquila*, of  $\alpha$  and  $\beta$  *Lyra*, of *Castor* and *Pollux*,† shew satisfactorily, that within such limits as these the instrument will measure differences of right ascension and north polar distance almost, if not altogether, as well as can be expected from the best meridian instruments.

Mr. Hartnup further remarks, that the instrument keeps its adjustments steadily, which seems to shew that it is not only firm in itself, but, also, that it rests on a sound foundation. The observations by Mr. Hartnup, of standard stars in all parts of the heavens, are not sufficiently numerous to yield a safe estimate of the probable error of a single independent determination, but it is evidently very small, even for stars at 6<sup>h</sup> from the meridian.

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*Mr. Bishop's Ecliptic Charts, from Observations at the South Villa Observatory.*

Our treasurer, Mr. Bishop, has lately published the first hour of an ecliptic chart for the epoch 1825. This contains all the stars to the 10 mag. inclusive in a zone of 6° of latitude, 3° on each side

\* This contrivance is peculiar to the equatorials of Cambridge and Liverpool, and in some researches is of great convenience.

† These observations are given in detail in the accompanying memoir.

the ecliptic. The scale is 1·2 inches to 1°, which gives a clear and open map. The execution is very good.

In the notice which accompanies the chart Mr. Bishop says, "It is the first of a series of twenty-four charts, which I hope to publish. . . . The discovery of planets is materially facilitated by mapping down the stars within a few degrees on each side the ecliptic; and it is for this purpose I have undertaken the present series of charts. . . . The stars included in Weisse's Catalogue from Bessel's Zones were first laid down for 1825 as points of reference. All other stars, to the tenth magnitude inclusive, were then entered by estimation of their positions with respect to the neighbouring members of Weisse's Catalogue. . . . The charts for the hours of right ascension in which the ecliptic falls beyond the declination limits of the Berlin maps ( $-15^\circ$ ) are in a state of forwardness, and will be published as soon as they are completed. They are regularly compared in their present state with the heavens, so that the search for planets and the formation of the charts are going on at the same time. . . . I take this opportunity of expressing my warmest thanks to Mr. J. R. Hind, for the great care and indefatigable zeal he has displayed in the formation of this chart, which, to my knowledge, he has examined with the heavens from fifty to sixty times; but the success of his research, as shewn by the discovery of two planets, speaks for itself, and will, I am sure, dispose astronomers to receive these charts with confidence."

The charts are published by Messrs. Taylor, Walton, and Maberly, Gower-street, London.

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*Extract of a Letter from Lieut. Gilliss,\* U.S.N.*

"The computations for the longitude of Washington, from corresponding moon-culminations observed by me between 1838–1842, are nearly completed. The results for 1839 and 1840 give the following corrections of the (hitherto received) longitude:—

1st Limb	— 5·39	by 182 comparisons	
2d Limb	— 4·41	74	—
Mean	— 4·84	256	— according to weight.

The European observatories with which the comparisons are made, are Edinburgh, Oxford, Greenwich, Cambridge, and Hamburg: the individual results very accordant; those from Cambridge strikingly so. Comparisons have also been made with the observations of Copenhagen, Kremsmunster, Cracow, and Wilna, which seem to shew considerable errors in the longitudes assigned to those observatories."

\* Lieut. Gilliss became very favourably known to many members of this Society on his visit to England a few years ago. The observations made at Washington were published in 1846 by the order of the Senate, and have been very freely distributed here and on the continent. They are a proof of what may be done with moderate means by a skilful and conscientious observer.

*Extracts of a Letter from Dr. Forster, of Bruges.*

"I have long wished to call the attention of the Society to a very curious fact in the chronology of lunations, if I may so express myself; but I have always been deterred by an apprehension that it had so much the air of superstition about it, that it might, in many minds, rather excite ridicule than interest. Still, however, facts are not to be despised, and I have resolved to point out to you, that whenever the new moon has fallen on a Saturday, the following twenty days have been wet and windy. This must depend on some cycle of lunations whose influence on our atmosphere has hitherto escaped the notice of meteorologists. I first perceived the coincidence to which I allude in Sussex, in the years 1817-27, and at that time thought it accidental, but on accurately examining a journal of the weather kept in my family by my grandfather, my father, and myself, in succession, I find that in every twenty Saturdays' new moons, nineteen have been actually stormy and the rest doubtful; and this has been the case ever since our journal began, A.D. 1767, up to the present time. I find, too, that the greatest storms of wind on record have been during the month following a *Saturday's moon*. It would be interesting to know whether this observation applies to other latitudes, and with a view of ascertaining the same, it is that I have thought it worth while to call the attention of the Society to the subject. For, during the last twenty-nine years, I have been enabled, in some measure, to predict the sort of weather that we should have for a long period, by examining the calculated times of new moon. It may here be observed, that stormy months, thus indicated, are characterised by the prevalence of S.W. and W. winds.

"*Periodical and other Meteors.*—On the night of the 13th of November last, a clear interval occurring between 10<sup>h</sup> and 13<sup>h</sup> 50<sup>m</sup>, I observed the sky to be marked by numerous small meteors shooting, in general, towards some point in the heavens, as nearly as I could judge N.N.W.; but unfortunately I was not in a position to make any accurate observations. Several hundreds of meteors must have occurred during the three hours and a half to which I allude; the clouds then closing the sky, I gave up observation. The meteors were small and very white, and generally left long trains behind them: one meteor had a contrary direction, it was larger than the rest, and moved slowly across the zenith towards the S.E. I am most decidedly of opinion that this phenomenon is altogether atmospherical and connected with electrical changes; nor does their motion, in the apparent direction of the magnetic poles, at all militate against this hypothesis of their electrical origin. A few occurred last 10th August, during a disturbed state of the atmospheric electricity; and I saw three on the 20th December."

*On the Variability of  $\lambda$  Tauri.* By Mr. Baxendell.

"On the night of the 6th instant I observed that the star  $\lambda$  Tauri was decidedly less bright than usual, being barely equal

to  $\gamma$ , a little less bright than  $\gamma$ , and decidedly below  $\delta$  and  $\xi$ , whilst on the previous night I had noted it down as being a little brighter than  $\delta$  and  $\xi$ , and decidedly above  $\gamma$  and  $\nu$ , and in all my former observations I had invariably placed it above  $\gamma$ . On the following night (the 7th) it had nearly recovered its usual lustre, being decidedly brighter than  $\nu$ , above  $\gamma$ , and equal to  $\delta$  and  $\xi$ . A short time previous to the 6th instant I had remarked that my former observations of the stars  $\delta$ ,  $\xi$ , and  $\lambda$  *Tauri* exhibited discordances which rendered it impossible to fix, with certainty, the order in which these stars ought to be placed. After the observations on the nights of the 6th and 7th instant, there could be no doubt that these discordances were mainly, if not wholly, due to the variability of  $\lambda$ ; and on carefully re-examining all my observations of this star, I was led to infer that its changes were accomplished in a period of only about four days. I therefore continued to watch it very closely, and on the night of the 10th instant had the satisfaction of again observing it reduced to an equality with  $\nu$ . As, however, the presence of the moon on that night might be supposed to have interfered with the estimations, I have continued my observations regularly since; and having observed  $\lambda$  decidedly reduced in brightness on the nights of the 14th, 18th, and 22d inst., I can no longer have any hesitation in concluding that this star belongs to the list of variable stars of short period, being, in fact, the next in order after  $\beta$  *Persei*, the period of which is the shortest yet known."

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Dr. Gerling, of Marburg, published (*Astron. Nach.* 502) an account of a method for determining the parallax of the sun by observations on *Venus* and *Mars* when nearest the earth, and requested the co-operation of American astronomers. Lieut. Gilliss, having satisfied himself that the method was feasible, volunteered his services to the American government to carry Dr. Gerling's proposal into effect, and the expedition is now preparing.

Lieut. Gilliss is to place himself in the most suitable station he can find on the coast of Chili, where he is to make meridian and extra-meridian observations of both planets, at the proper times, in correspondence with other observers at home. He also proposes to observe an extensive catalogue of southern stars, and make various astronomical and magnetical observations. His instruments are a 3-foot meridian circle, with a telescope of 52 lines aperture, made by Pistor and Martius, of Berlin, under Professor Encke's direction; a 5-foot equatoreal, with clock motion, by Fraunhofer; clock, chronometers, &c. Lieut. Gilliss expects to leave home in about six months, and to be absent two or three years.

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At the close of the evening the Chairman informed the meeting that the Astronomer Royal had presented the models of Lord Rosse's telescope and polishing machine to the Society. Thanks were returned to the Astronomer Royal for his present. They are now in the meeting-room for examination.

# ROYAL ASTRONOMICAL SOCIETY.

VOL. IX.

January 12, 1849.

No. 3.

CAPT. W. H. SMYTH, R.N., Vice-President, in the Chair.

The Rev. A. D. Wackerbarth, Riverside, St. Peter's, Hammer-smith;

Samuel Charles Whitbread, Esq., Cardington, Bedfordshire;

The Rt. Hon. Sir Lancelot Shadwell, Vice-Chancellor of England;

W. M. Fisher, Esq., 39 Great George Street, Liverpool;

Rev. Alfred Weld, Director of the Observatory at Stonehurst College, Lancashire;

Charles B. Chalmers, Esq., Weston Super Mare, Somerset;

Rev. J. N. Peill, B.D., Queen's College, Cambridge;

George William Carrington, Esq., 2 Park Prospect, St. James's Park;

were balloted for and duly elected Fellows of the Society.

Wm. Cranch Bond, Esq., M.A., Director of the Observatory at Cambridge, Massachusetts, Fellow of the American Academy of Arts and Sciences, &c., was balloted for, and duly elected an Associate of the Society.

## *Transit of Mercury, Nov. 8 and 9, 1848, at Durham.*

External Contact at Nov. 8, 23<sup>h</sup> 5<sup>m</sup> 32<sup>s</sup>.14, Greenwich M.T. very uncertain

Internal Contact — 6 55.90, — ingress complete.

These observations were made by Mr. Thompson with the Fraunhofer equatoreal.

The same phenomena were observed by Professor Chevallier and another observer, the image of the sun being projected on a screen.

	Professor Chevallier.	2d Observer.	
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	
External Contact	23 5 50.78	23 5 40.81	Greenwich M.T.
Internal Contact	7 21.53	7 10.57	

The following observations were made by Professor Chevallier with the Northumberland equatoreal of 5 inches' aperture and 7 feet focal length; they are corrected for the difference of refraction and parallax, and for the sun's motion in the interval between the observations of the planet and the sun: the images of the sun and planet were thrown on a screen:—

*Differences of Right Ascension of the Centres of Mercury and the Sun, Mercury compared with Sun's Second Limb.*

	Greenwich			R.A. Mercury	No.		Greenwich			R.A. Mercury	No.
1848.	M.T.			— R.A. Sun.	Obs.		M.T.			— R.A. Sun.	Obs.
Nov. 8	h	m	s			Nov. 8	h	m	s		
	23	12	18.74	+ 62.68	9		23	33	4.84	+ 54.80	7
		17	4.99	60.84	10			0 40	18.20	51.99	3
		21	13.85	59.36	10		9	0 28	43.82	34.05	6
		27	58.93	+ 56.70	10			1 15	38.18	+ 16.52	6

The transits of Mercury and of the second limb of the sun were observed over one meridian wire at each observation.

In the following observations the transits of the planet and of both limbs of the sun were observed over the meridian wire placed in the focus :—

	Greenwich M.T.			R.A. Mercury — R.A. Sun.			Greenwich M.T.			R.A. Mercury — R.A. Sun.
	h	m	s				h	m	s	
Nov. 9	1	23	0.22	+ 13.93		Nov. 9	1	28	12.44	+ 12.08
		25	37.08	+ 12.70				31	4.46	+ 10.78

The image of the sun was now referred to five equidistant wires drawn on the screen itself; but this method was found to be inaccurate, as the screen required frequent readjustment.

	Greenwich			R.A. Mercury			Greenwich			R.A. Mercury	
	M.T.			— R.A. Sun.			M.T.			— R.A. Sun.	
	<sup>h</sup>	<sup>m</sup>	<sup>s</sup>		<sup>s</sup>		<sup>h</sup>	<sup>m</sup>	<sup>s</sup>		<sup>s</sup>
Nov. 9	1	40	33.81		+ 7.00	Nov. 9	2	8	0.11		— 2.81
		44	18.40		+ 6.22			11	21.30		3.95
		48	58.62		+ 4.18			15	44.86		6.01
	2	1	2.99		— 0.41			20	35.1		— 7.36
		4	46.81		— 1.70						

The semidiameter of the *Nautical Almanac*, used in the above computations, agrees very well with the semidiameter obtained by the observed transits on the screen: 15 observed transits give  $1^m 7^s.946$ , instead of  $1^m 7^s.87$ .

*Differences of North Polar Distance of Centres of Mercury and Sun, observed by Mr. Thompson with the Fraunhofer Equatoreal.*

1st. When the planet is compared with south limb of the sun.

	Greenwich M.T.			N.P.D. Mercury — N.P.D. Sun.	Limb Planet Obs <sup>d</sup> .		Greenwich M.T.			N.P.D. Mercury — N.P.D. Sun.	Limb Planet Obs <sup>d</sup> .
	<sup>h</sup>	<sup>m</sup>	<sup>s</sup>				<sup>h</sup>	<sup>m</sup>	<sup>s</sup>		
Nov. 8	23	12	2.1	+ 3 56.1	Cent.	Nov. 9	1	19	4.2	— 1 23.4	N.
	(16)	5.5		3 50.5	S.		21	22.9	1 27.3	N.	
	22	52.3		3 25.7	Both		23	39.5	1 30.8	Both	
	31	25.9		3 0.3	N.		25	41.1	1 37.3	Both	
	36	20.1		2 52.4	Both		27	12.9	1 40.6	N.	
	23	40	20.5	2 39.0	N.		28	54.5	1 49.9	Both	
Nov. 9		32	30.9	+ 0 32.2	Both		1	30	45.3	— 1 50.8	Both
	1	15	58.7	— 1 15.1	Both						

2d. When the planet is compared with the north limb of the sun.

1848.	Greenwich M.T.			N.P.D. Mercury — N.P.D. Sun.	Limb Planet Obsd.		Nov. 9	Greenwich M.T.			N.P.D. Mercury — N.P.D. Sun.	Limb Planet Obsd.	
	h	m	s					h	m	s			
Nov. 9	1	36	39.3	— 1	59.2	Both	Nov. 9	1	58	56.7	— 2	52.4	Both
		38	53.9	2	3.9	Do.		2	1	1.4	3	0.4	Do.
		40	39.7	2	7.7	Do.			(4)	0.9	3	4.7	Do.
		45	28.9	2	19.4	Do.			18	46.0	3	40.8	Do.
		47	13.5	2	25.5	S.			19	54.3	3	44.4	Do.
		49	13.2	2	22.3	Cent.			23	22.8	3	50.9	S.
		51	12.9	2	31.3	S.			25	32.4	3	59.8	Both
		54	35.4	2	42.9	Both		2	27	5.2	— 4	5.3	N.
	1	56	21.1	— 2	46.3	Do.							

"When the number of minutes is placed within brackets, there is an uncertainty of a minute.

"In the earlier part of the observations, the sun's limb was ill-defined in the equatoreal; but it was well seen afterwards. The sun's image received on a screen was very clear throughout the observations."

Mr. Thompson made some observations in right ascension with the Fraunhofer equatoreal at the beginning of the transit, but the sun's limb was so badly defined and the wind so troublesome at that time, that he does not place any reliance on them.

## IRIS.

LIVERPOOL.				Equatoreal.				(Mr. Hartnup.)			
Greenwich M.T.				R.A.		Log $\frac{p}{P}$		N.P.D.		Log $\frac{q}{P}$ Star.	
1848.	h	m	s	h	m	s		°	'		
Dec. 21	13	24	11.7	10	26	55.39	-8.474	86	38	9.7	-9.889 a
	14	0	22.7			55.62	8.400		16.3		9.887 a
	14	31	53.6			55.84	8.313		22.7		9.885 a
1849.											
Jan. 3	14	18	31.8	10	27	8.33	8.188	87	30	30.3	9.890 b
	14	53	12.5			8.11	-8.129		33.4		-9.889 b
a.....B.A.C. 3684						b.....B.A.C. 3600					

The places of the stars are taken from the catalogue. Log  $\frac{p}{P}$  and log  $\frac{q}{P}$  have the signification given to them by Professor Challis, in vol. viii. p. 206, of the *Monthly Notices*.

HAMBURG.			Equatoreal.			(M. C. Rümker.)		
Hamburg M.T.			R.A.			Decl.		
1848.	h	m	s	h	m	s	°	'
Dec. 10	15	21	14.7	155	42	48.5	+ 4	26 51.8
	14	13	21 56.3	156	10	45.7	4	1 32.4
	19	13	13 47.0			36 22.2	3	32 34.0
	20	13	0 2.0			40 13.8		27 23.7
	21	12	43 1.6			43 37.4		22 13.8
	24	12	39 59.8			51 27.5	3	7 17.6
	26	12	12 34.6			54 21.0	2	58 37.1
	28	12	10 20.9	156	55	21.5	+ 2	50 18.7

## Meridian Circle.

	Hamburg M.T.	R.A.	Decl.
1848.	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
Dec. 28	16 6 50.3	156 55 19.1	+ 2 49 39.7
29	15 52 54.5	54 56.3	45 48.4
1849.			
Jan. 1	40 53.8	51 40.9	35 26.2
2	36 49.2	49 31.8	32 18.6
3	32 43.6	47 4.2	29 26.6
4	15 28 35.8	156 44 3.0	+ 2 26 43.5

## Elements. By Mr. Norman Pogson.

Epoch 1849, Jan. 0.0, Greenwich M.T.

Mean Anomaly .....	68 44 5.05	
" .....	41 21 2.43	} Mean Equinox, 1849, Jan. 0.0
Ω .....	259 47 14.88	
i .....	5 28 13.74	
φ .....	13 19 42.20	
e .....	0.2305366	
Log a .....	0.3772307	
a .....	2.3835872	
Log q .....	0.2634187	
q .....	1.8340821	
Log μ .....	2.9841605	
μ .....	964'' 1851	
Sid. Period .....	1344.139 days.	

From observations made in 1848, at Cambridge on Feb. 17th, and at South Villa on Aug. 7th and Dec. 13th.

The above elements, when compared with the middle observation, give the following equations :—

Observed—Computed.

In Longitude.....	= + 0.83
In Latitude .....	= + 0.14

## FLORA.

HAMBURG.

Equatoreal.

(M. C. Rümker.)

	Hamburg M.T.	R.A.	Decl.
1848.	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
Dec. 24	17 14 36.1	207 11 12.7	— 5 37 14.2
28	17 0 19.0	208 28 56.0	5 58 51.5
29	17 45 7.5	208 48 48.8	6 4 21.7
1849.			
Jan. 2	17 35 10.2	210 3 40.7	6 23 35.9
3	16 55 51.0	210 21 17.4	— 6 28 1.5

## NEPTUNE.

## LIVERPOOL.

## Equatoreal.

(Mr. Hartnup.)

	Greenwich M.T.			R.A.			Obs <sup>d</sup> —Calc <sup>d</sup>			N.P.D.			Obs <sup>d</sup> —Calc <sup>d</sup>		
	h	m	s	h	m	s	°	'	"	°	'	"	°	'	"
1848.															
Nov. 30	6	46	21.6	22	9	1.35	—1	53		102	7	14.7	+	8.3	
Dec. 5	7	22	31.9		9	16.33		1.42			5	50.3		8.3	
6	7	38	9.9		9	19.33		1.46			5	31.2		8.3	
11	8	23	17.7		9	38.02		1.12			3	44.2		6.6	
15	5	4	7.0		9	53.92		1.46			2	13.1		7.6	
19	5	14	38.5		10	13.99		1.21		102	0	26.9		7.1	
21	4	45	32.7		10	23.86		1.13		101	59	32.6		8.7	
22	5	41	4.3		10	28.01		1.22			59	4.0		10.5	
28	5	28	47.7		11	1.19		1.18			55	53.4		7.0	
1849.															
Jan. 2	5	59	31.6	22	11	31.60	—1	32		101	53	3.9	+	9.4	

"The observations have been corrected for refraction and parallax, and compared with Mr. Adams's Ephemeris.

"The stars of comparison for Nov. 30 and Dec. 5 are the mean of 7722 and 7821 B.A.C.; for Dec. 6, 7722 B.A.C.; and for the remainder, 7821 B.A.C. The places have been taken from the catalogue cited."

## HEBE.

## HAMBURG.

## Equatoreal.

(M. C. Rümker.)

	Hamburg M.T.			R.A.			Decl.			No. Comps.		
	h	m	s	h	m	s	°	'	"			
1848.												
Nov. 19	11	2	45.6	97	36	43.1	+2	30	19.0		13	
21	16	25	25.5		19	58.8		28	5.9		12	
22	10	21	27.6		14	28.0		26	33.9		14	
23	10	18	51.0	97	5	51.5		25	31.6		4	
24	16	31	19.6	96	54	21.8		24	56.8		7	
29	9	27	46.3	96	5	58.2		25	28.7.2		1	
Dec. 2	10	59	28.9	95	29	13.9		28	53.5		18	
3	9	58	8.0	95	17	4.5		30	27.6		16	
5	9	52	59.6	94	50	52.2		34	28.9		5	
11	9	45	57.7	93	25	5.5		2	52	35.6		
14	9	0	26.8	92	39	43.0		3	5	14.2		
17	10	17	18.8	91	51	59.9		+3	20	32.8		

## Meridian Circle.

	h			°			°		
	m	s	"	m	s	"	m	s	"
1848.									
Dec. 14	12	34	25.3	92	37	24.5	+3	5	51.7
17	20	30.5		91	50	32.0		21	5.3
19	10	33.0		19	2.8			32	18.2
20	5	33.9		91	3	11.1		38	20.1
21	12	0	35.1	90	47	25.6		3	44
24	11	45	39.4	90	0	20.0		4	4
26	35	44.2		89	29	24.5		19	
28	25	51.4		88	59	4.8		34	
29	20	56.0		44	10.0			4	
1849.									
Jan. 1	6	15.5		88	0	51.6		5	
2	11	1	23.9	87	46	53.8			
3	10	56	33.7	33	17.1				
4	10	51	44.5	87	19	56.1			

## METIS.

*Letter from Mr. Graham.*

"The enclosed ephemeris of *Metis* is founded on the following set of elements:—

Epoch 1848, May 0<sup>o</sup>, Greenwich Mean Time.

M	.....	144 24 39 <sup>o</sup> 9	} Mean Eq <sup>r</sup> . May 0 <sup>o</sup>
$\pi - \Omega$	.....	2 28 54 <sup>o</sup> 0	
$\Omega$	.....	68 28 44 <sup>o</sup> 0	
i	.....	5 35 34 <sup>o</sup> 5	
$\phi$	.....	7 2 53 <sup>o</sup> 85	
Log a	.....	0.3776688	
$\mu$	.....	962 <sup>o</sup> 7275	

"These agree very fairly with the following places, which were obtained by the aid of my second set of elements. The places are referred to mean equinox May 0<sup>o</sup>, and have been corrected for the perturbations of the *Earth*, *Mars*, *Jupiter*, and *Saturn*, from the epoch.

G.M.T.	Geo. Long.	Geo. Lat.	Obs.
1848. May 6 <sup>o</sup> 5	222 39 31 <sup>o</sup> 12	3 44 20 <sup>o</sup> 22	31
26 <sup>o</sup> 5	218 15 43 <sup>o</sup> 00	2 58 40 <sup>o</sup> 72	38
June 15 <sup>o</sup> 4	215 58 29 <sup>o</sup> 13	2 9 30 <sup>o</sup> 14	13
July 5 <sup>o</sup> 4	216 17 57 <sup>o</sup> 54	1 25 10 <sup>o</sup> 71	14
26 <sup>o</sup> 1	219 4 58 <sup>o</sup> 78	0 47 16 <sup>o</sup> 92	3

"For the last three observations we are indebted to the Cambridge Observatory.

"The corrections of those calculated by these places are,—

	Long.	Lat.
May 6 <sup>o</sup> 5	0 <sup>o</sup> 00	0 <sup>o</sup> 00
26 <sup>o</sup> 5	-0 <sup>o</sup> 15	-0 <sup>o</sup> 06
June 15 <sup>o</sup> 4	+3 <sup>o</sup> 36	-6 <sup>o</sup> 54
July 5 <sup>o</sup> 4	+1 <sup>o</sup> 51	-1 <sup>o</sup> 88
26 <sup>o</sup> 1	-0 <sup>o</sup> 04	0 <sup>o</sup> 00

"In calculating the ephemeris I made use of these constants,—

A	160 52 35 <sup>o</sup> 4	+1 <sup>o</sup> 003 d 88
B	73 21 15 <sup>o</sup> 7	+1 <sup>o</sup> 011
C	60 7 10 <sup>o</sup> 2	+0 <sup>o</sup> 889
Log a	9.9982074	-0 <sup>o</sup> 08 d 58
b	9.9558466	+0 <sup>o</sup> 92
c	9.6418949	-3 <sup>o</sup> 55

"d 88 is to be reckoned from 1849, Jan. 1<sup>o</sup>0.

$$x = ra \sin (A + v)$$

$$y = rb \sin (B + v)$$

$$z = rc \sin (C + v)$$

" It was my original design to correct the ephemeris for the perturbations; but the orbit is still so uncertain that I judge it better to publish the results as they are than to go over ground which might have to be retraced.

*Ephemeris.*

Greenwich Mean Midnight.							
		R.A.			N.P.D.		Log Δ
		h	m	s	°	'	
1849.							
Feb.	1	19	28	26.65	114	13 26.7	0.54469
	2		30	18.34		10 33.3	.54395
	3		32	9.85		7 36.0	.54320
	4		34	1.17		4 34.6	.54242
	5		35	52.28	114	1 29.4	.54163
	6		37	43.21	113	58 20.3	.54082
	7		39	33.92		55 7.3	.54000
	8		41	24.43		51 50.5	.53916
	9		43	14.73		48 29.9	.53830
	10		45	4.82		45 5.7	.53742
	11		46	54.69		41 37.9	.53653
	12		48	44.34		38 6.4	.53562
	13		50	33.76		34 31.4	.53469
	14		52	22.95		30 52.9	.53375
	15		54	11.89		27 11.0	.53279
	16		56	0.60		23 25.7	.53181
	17		57	49.06		19 37.1	.53081
	18	19	59	37.26		15 45.3	.52980
	19	20	1	25.21		11 50.3	.52876
	20		3	12.89		7 52.1	.52771
	21		5	0.29	113	3 50.9	.52665
	22		6	47.42	112	59 46.7	.52556
	23		8	34.27		55 39.6	.52446
	24		10	20.82		51 29.6	.52335
	25		12	7.08		47 16.7	.52221
	26		13	53.04		43 1.2	.52106
	27		15	38.70		38 43.0	.51989
	28		17	24.04		34 22.2	.51870
March	1		19	9.07		29 58.8	.51750
	2		20	53.79		25 33.0	.51628
	3		22	38.19		21 4.8	.51504
	4		24	22.26		16 34.2	.51378
	5		26	6.01		12 1.3	.51251
	6		27	49.43		7 26.2	.51122
	7		29	32.52	112	2 49.0	.50991
	8		31	15.28	111	58 9.7	.50859
	9		32	57.70		53 25.8	.50725
	10		34	39.77		48 45.3	.50590
	11		36	21.51		44 0.1	.50452
	12		38	2.90		39 13.2	.50313
	13		39	43.94		34 24.6	.50172
	14		41	24.62		29 34.2	.50029
	15		43	4.94		24 42.3	.49884

		R.A. h m s	N.P.D. ° ' "	Log Δ
1849.				
March	16	29 44 44.89	111 19 48.9	9.49738
	17	46 24.47	14 54.1	.49590
	18	48 33.67	9 58.0	.49440
	19	49 42.49	5 0.6	.49289
	20	51 20.92	111 0 2.1	.49135
	21	52 58.96	110 55 2.6	.48980
	22	54 36.58	50 2.0	.48823
	23	56 13.81	45 0.6	.48665
	24	57 50.62	39 58.3	.48504
	25	20 59 27.01	34 55.4	.48342
	26	21 1 2.98	29 51.7	.48178
	27	2 38.52	24 47.5	.48012
	28	4 13.62	19 42.9	.47844
	29	5 48.29	14 37.8	.47675
	30	7 22.52	9 32.5	.47504
	31	8 56.30	110 4 26.9	.47331
April	1	10 29.63	109 59 21.3	.47156
	2	12 2.50	54 15.5	.46980
	3	13 34.92	49 9.9	.46802
	4	15 6.87	44 4.4	.46623
	5	16 38.37	38 59.0	.46441
	6	18 9.40	33 53.9	.46258
	7	19 39.95	28 49.1	.46073
	8	21 10.04	23 44.8	.45886
	9	22 39.62	18 41.1	.45698
	10	24 8.74	13 38.0	.45508
	11	25 37.36	8 35.6	.45316
	12	27 5.48	109 3 34.1	.45122
	13	28 33.10	108 58 33.6	.44927
	14	30 0.21	53 34.0	.44730
	15	31 26.80	48 35.7	.44531
	16	32 52.85	43 38.6	.44330
	17	34 18.37	38 42.9	.44128
	18	35 43.35	33 48.7	.43923
	19	37 7.77	28 56.1	.43716
	20	38 31.64	24 5.2	.43509
	21	39 54.94	19 16.1	.43299
	22	41 17.66	14 28.9	.43088
	23	42 39.80	9 43.7	.42875
	24	44 1.35	5 0.6	.42660
	25	45 22.30	108 0 19.7	.42443
	26	46 42.65	107 55 41.3	.42225
	27	48 2.38	51 5.2	.42004
	28	49 21.48	46 31.7	.41783
	29	50 39.96	42 0.8	.41559
	30	51 57.81	37 32.7	.41334
May	1	53 15.03	33 7.4	.41107
	2	54 31.59	28 45.0	.40879
	3	21 55 47.51	107 24 25.9	0.40649

Corrected for aberration, but not for perturbations.

## PETERSEN'S SECOND COMET.

LIVERPOOL.*			Equatoreal.			(Mr. Hartnup.)		
Greenwich M.T.			R.A.			N.P.D.		
h m s			h m s			° ' "		
1848.			h m s			° ' "		
Dec. 17			h m s			° ' "		
5	56	28.9	21	59	59.62	82	7	47.8
6	8	57.6	22	0	1.14	8	24.4	1.20
6	17	25.4			2.30	8	54.4	1.27
6	38	10.0			5.28	9	58.6	1.26
6	47	33.1			6.85	10	32.1	1.05
7	13	56.3			10.46	11	59.1	1.23
7	30	31.9			12.80	12	52.3	1.20
7	46	56.3			15.16	13	49.9	1.27
19	5	51	22	6	47.62	84	44	26.1
	5	59			48.45	44	46.5	1.42
20	7	30	22	10	22.34	86	6	34.0
	7	43			24.44	7	15.6	0.69
21	5	49	22	13	26.73	87	17	7.2
	6	2			28.78	17	52.4	0.23
	6	18			30.69	18	37.3	1.01
	6	29			32.30	19	14.5	0.91
	6	48			34.58	20	13.1	1.27
22	6	27	22	16	48.18	88	33	50.1
	6	45			50.18	34	37.5	1.24
	7	10			53.87	35	54.3	1.03
23	7	11	22	20	7.64	89	49	28.0
	7	23			9.18	50	4.9	1.00
28	6	26	22	35	36.37	95	34	58.1
1849.	6	54			39.85	36	11.1	0.73
Jan. 15	6	0	23	24	46.14	112	6	44.5
	6	20			47.79	7	27.1	...
	6	36			49.50	8	3.9	...
	6	51			51.18	8	25.6	...
	6	0			46.14	6	44.5	...
	6	20			47.79	7	27.1	...
	6	36			49.52	8	3.9	...
	6	51			51.18	8	25.6	...
	7	4			52.75	8	41.9	...
	7	22			54.54	9	9.5	...

"The corrections are to be applied algebraically to the ephemeris to represent the observations.

"All the observations, except those of Jan. 15, are made with illuminated wires on a dark field; the powers used were 180 for the first series and 134 for the rest.

"The declinations on Dec. 21, 22, and Jan. 15, are deduced from the readings of the declination circle; on the other days the differences of declination were measured by the micrometer.

"On Jan. 15 the illuminated wires were found to be too bright, and I employed a reticule with thick wires, five for transits and two crossing the field, and cutting each other at an angle for declination. The star of comparison and the comet were

\* These observations are given in fuller detail than is usual, to enable astronomers to judge of the probable accuracy of the determinations of the Liverpool observatory, which is now completely furnished and in full activity.

made to pass at the angle thus formed. The assumed mean places of  $a$  and  $b$  for Jan. 1, 1849, are

$a$	R.A. =	$21^{\text{h}} 55^{\text{m}} 7^{\text{s}}.02$	N.P.D. =	$82^{\circ} 12' 55''.26$
$b$		$22 \quad 8 \quad 25^{\text{s}}.87$		$82 \quad 12 \quad 17''.24$

as found by one comparison by the equatoreal with 7788, 7833 B.A.C. The other stars are taken from the B.A.C. catalogue.

"In the last six observations of Jan. 11, the comet was so low that the Greenwich Refraction Tables do not apply. I, therefore, computed the refraction from Argelander's supplemental table in the *Tabulæ Regiomontanæ*.

"Easterly winds and fog rendered the definition of the comet somewhat vague in general; but on two or three favourable occasions the nucleus appeared stellar; and even through fog and haze the light was sufficiently condensed about the centre to admit of accurate bisection."

HAMBURG.		Equatoreal.	(M. C. Rümker.)
1848.	Hamburg M.T.	R.A.	Decl.
	$^{\text{h}} \quad ^{\text{m}} \quad ^{\text{s}}$	$^{\circ} \quad ' \quad ''$	$^{\circ} \quad ' \quad ''$
Nov. 7	16 34 44.4	288 35 33.0	+ 55 25 16.1
8	16 36 43.4	289 45 55.9	54 38 3.5
14	6 20 3.4	296 13 6.3	49 47 1.2
15	5 57 6.5	297 20 53.3	48 50 9.3
19	5 45 30.9	301 52 55.7	44 43 40.2
20	5 45 16.3	303 0 28.3	43 37 44.8
21	5 52 58.7	304 7 44.4	42 30 5.3
22	7 54 12.9	305 19 38.8	41 15 15.1
23	7 5 13.8	306 23 21.0	40 6 59.6
25	7 29 33.3	308 35 17.5	37 39 43.8
29	6 42 25.0	313 43 26.5	32 26 11.4
Dec. 1	7 5 52.7	314 53 51.4	29 53 28.3
2	6 37 20.6	315 54 3.8	28 33 48.4
3	8 10 53.6	316 58 33.5	27 6 8.9
5	6 57 5.3	318 54 50.3	24 24 16.1
	6 56 35.2	55 15.9	24 24.2
9	6 3 20.4	322 44 52.5	18 52 13.1
10	6 7 52.8	323 41 38.9	17 27 58.3
11	5 30 10.0	324 35 39.5	16 6 41.4
12	6 27 20.2	325 32 48.5	14 35 11.4
13	5 57 21.8	326 26 35.1	13 19 1.4
17	6 23 3.2	329 59 19.6	7 53 4.9
19	9 23 14.7	331 47 55.6	5 6 29.2
20	5 49 37.7	332 30 54.4	+ 4 0 51.9
24	5 52 15.4	335 45 50.0	- 0 55 33.4
28	6 41 3.1	338 53 24.4	5 33 49.5
29	5 53 32.8	339 36 58.6	6 37 38.7
30	6 21 38.4	340 22 20.4	7 42 55.3
1849.			
Jan. 1	7 3 28.2	341 51 0.4	9 49 47.4
2	5 45 8.0	342 32 28.7	10 46 53.9
3	5 44 3.5	343 14 10.5	11 45 55.4
4	6 3 43.0	343 57 1.1	- 12 44 40.7

*Note.*—On Dec. 5, at  $6^{\text{h}} 57^{\text{m}} 53^{\text{s}}$ , Hamburg M.T., the nucleus of the comet covered a fixed star, observed by Bessel, zone 323. The star was seen distinctly *through* the comet.

HAMBURG.				(M. C. Rümker.)			
1848.	Hamburg M.T.			R.A.	No. Obs.	Decl.	No. Obs.
	<sup>h</sup>	<sup>m</sup>	<sup>s</sup>	<sup>o</sup> ' "		<sup>o</sup> ' "	
Dec. 1	7	33	35.3		2	+ 29 52 10.0	1
	7	41	26.1	20 59 41.80			
5	6	57	35	21 15 39.35		24 24 42.5	
10	6	58	11.8	34 54.45	7	17 24 57.7	7
11	6	13	17.2	21 38 29.73	6	+ 16 4 31.8	6
24	6	53	12.0	22 23 11.97	4	— 0 58 33.1	4
28	7	26	35.3	35 38.75	6	5 35 43.8	6
29	6	57	49.0	22 38 35.67	8	— 6 40 28.7	8

Not corrected for parallax or refraction.

*Corrections of Lindenau's Elements of the Orbit of Venus, deduced from the Greenwich Planetary Observations, 1750–1830.* By Mr. Hugh Breen, of the Royal Observatory, Greenwich.

In the Greenwich observations from 1750 to 1830 are contained upwards of one thousand observations of *Venus*, and it seems plain that corrections of the elements of her orbit deduced from so extensive a series of observations must be valuable. Impressed with this conviction, the late Mr. Hugh Breen commenced this work, which has been brought to completion by the author with the assistance of his brother, Mr. James Breen, of the Cambridge observatory.

Lindenau's corrected elements of the epoch 1750 were deduced from Bradley's Greenwich observations, 1750–1756. When the places used by him are compared with those given in the Greenwich Planetary Reductions sensible differences are frequently found. In 23 cases out of 78, the difference of R.A. exceeds 5"; and in finding the N.P.D. Lindenau appears to have overlooked the index error of the iron quadrant from 1750–1753, which in some instances amounted to 14".

If the solar tables be supposed to be correct, and the perturbations of *Venus* to be rightly tabulated, any error in the computed place can only arise from errors in the elements of the orbit employed in constructing the tables. In the Greenwich Reductions, the error of geocentric longitude for each mean group of observations is expressed in terms of the errors of heliocentric longitude and radius vector.

By an investigation which the author gives, and which besides is well known, these latter errors may be expressed in terms of the errors of the elements. Since the inclination of the orbit is small, the reduction to the ecliptic may be supposed to be exactly known, and the error of longitude will be nearly independent of the errors of the node and inclination. Hence each mean group of observations furnishes an equation of condition between the errors of the

mean distance, the eccentricity, the epoch of mean longitude, and the longitude of the aphelion. The formation of the equations is given in a series of tables, and in such detail that any portion of the work may be readily verified. The 254 equations thus formed are then divided into groups of convenient extent, and each group is separately solved in the following manner. Each equation of condition is multiplied by the number of observations on which it depends, and the resulting equations are combined by addition, after changing the signs so that the co-efficients of each of the unknown quantities in succession are made positive.

The errors of the tabular elements obtained for different periods are given in the following table:—

No. of Eq <sup>ns</sup> .	Extent of Group.		$\delta a$	$\delta e$	$\delta i$	$\delta \Pi$
1-33	1750 Oct. 13, to	1755 July 28	+0.0000179	+0.0000145	-2.81	-55.2
34-68	1756 Mar. 5,	1761 Nov. 11	0.0000111	0.0000179	3.46	87.2
69-104	1762 July 5,	1769 Aug. 10	0.0000039	0.0000134	5.28	141.1
34-57	1756	1759	0.0000167	0.0000233	6.87	14.9
58-80	1759 Sept. 19,	1763 Aug. 29	0.0000071	+0.0000130	1.71	98.9
122-140	1788 May 29,	1799 Dec. 26	0.0000037	-0.0000087	-0.76	-403.7
147-158	1811 Aug. 24,	1818 June 1	0.0000118	0.0000012	+3.52	+81.7
159-200	1819 Feb. 15,	1822 Dec. 1	0.0000111	0.0000099	+1.00	-238.2
201-227	1823 Mar. 23,	1826 Aug. 30	0.0000046	0.0000219	-1.57	269.2
228-254	1828 Feb. 15,	1830 Nov. 16	+0.0000111	-0.0000145	-2.34	-351.8

The first group consists of the observations from which Lindenau derived his corrections of Lalande's Elements at the epoch 1750.

The errors of heliocentric ecliptic solar distance are next treated in a similar manner to those of the longitude.

As the inclination of the orbit is small, the errors of longitude, which are themselves in general small, will produce only an inappreciable effect on the errors of ecliptic polar distance, which may, therefore, be taken to depend solely on the errors of the node and inclination. The equations of condition are consequently very simple, and each group has been solved by the method of least squares. The following table gives the resulting errors of the elements:—

No. of Eq <sup>ns</sup> .	Extent of Group.		$\delta N.$	$\delta I.$
1-33	1750 Oct. 13, to	1755 July 28	+ 90.6	-8.27
34-57	1756 March 5,	1759 Aug. 3	108.5	4.05
58-80	1759 Sept. 19,	1763 Aug. 29	115.5	7.08
81-104	1764 Jan. 31,	1769 Aug. 10	94.5	5.07
122-140	1788 May 29,	1799 Dec. 26	30.5	3.76
147-158	1811 Aug. 24,	1818 June 1	25.6	4.54
159-200	1819 Feb. 15,	1822 Dec. 1	43.8	3.18
201-227	1823 March 23,	1826 Aug. 30	34.3	4.57
228-254	1828 Feb. 15,	1830 Nov. 16	+ 7.4	-2.21

The large errors of the node and inclination at the epoch 1750–1755, probably arise from the neglect of the index error of Graham's quadrant, from 1750–1753, before mentioned.

*On that Part of the Equation of Time which Depends on the Obliquity of the Ecliptic.* By John Riddle, Esq.

“Let  $\omega$  = obliquity;  $l$  = sun's longitude;  $a$  = sun's right ascension;  $\delta$  = sun's declination.

Then  $l - a = x$  = that part of the equation of time here spoken of.

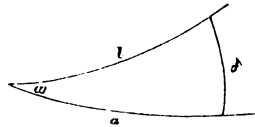
$$\text{Now, } \cos \omega = \tan a \cdot \cot l,$$

$$\text{or } \frac{\cos \omega}{1} = \frac{\tan a}{\tan l}$$

$$\frac{1 + \cos \omega}{1 - \cos \omega} = \frac{\tan l + \tan a}{\tan l - \tan a};$$

$$\text{or } \cot^2 \frac{\omega}{2} = \frac{\sin(l+a)}{\sin(l-a)} = \frac{\sin(l+a)}{\sin x}$$

$$\therefore \sin x = \sin(l+a) \cdot \tan^2 \frac{\omega}{2}.$$



“From this it is evident that  $\sin x$  and  $x = 0$  when  $\sin(l+a) = 0$ , that is, when  $l+a = 0; 180^\circ; 360^\circ$ ; or  $540^\circ$ ; and these values of  $l+a$  occur at the equinoxes and solstices.

“The greatest values of  $\sin x$  and of  $x$  correspond to the greatest value of  $\sin(l+a)$ , viz. when

$$l+a = 90^\circ, 270^\circ, 450^\circ \text{ or } 630^\circ,$$

$$\text{and } \sin(l+a) = 1, -1, 1 \text{ or } -1;$$

which will give  $x$  alternately positive and negative; if  $X$  be the maximum value of  $x$ ,

$$\sin X = \pm \tan^2 \frac{\omega}{2} \dots\dots\dots 1$$

$$\text{“ Again, when } l+a = 90^\circ$$

$$2l - (l-a) = 90^\circ$$

$$\text{or } 2l - X = 90^\circ$$

$$\text{and } l = \frac{1}{2}(90^\circ + X) \dots\dots\dots 2$$

$$\text{and } a = (90^\circ - l) \dots\dots\dots 3$$

“Also, when  $x = X$ ,

$$\cos l = \cos a \cdot \cos \delta$$

$$= \sin l \cdot \cos \delta \quad (\cos a = \sin l, \text{ equat. 3})$$

$$\therefore \cot l = \cos \delta \dots\dots\dots 4$$

“The equations (1), (2), (3), (4), furnish an easy means of finding

successively the quantities  $x$ ,  $l$ ,  $a$ , and  $\delta$ , when  $x$  is at its maximum value. Collecting them we have

$$\begin{aligned}\sin X &= \tan^2 \frac{a}{2} \\ l &= \frac{1}{2}(90 + X) \\ a &= 90 - l \\ \cot l &= \cos \delta\end{aligned}$$

Let

$$\begin{aligned}a &= 23^\circ 27' 36'' \\ \frac{a}{2} &= 11^\circ 43' 48'' \\ \tan \frac{a}{2} &= 9.3173030 \\ \sin X &= \underline{8.6346060} \\ X &= 2^\circ 28' 15''.5 \\ l &= 46^\circ 14' 7''.75 \\ a &= 43^\circ 45' 52''.25\end{aligned}$$

$l$  and  $a$  are found, almost by inspection, from  $x$ , and for  $\delta$ ,

$$\delta = \cos^{-1}(\cot l) = \cos^{-1}[\cot 46^\circ 14' 7''.75] = 16^\circ 42' 32''.$$

“That some of the relations expressed are new, I have some reason to believe; they are certainly concise, and exhibit the dependence of the various quantities on each other, better than those which are usually given in the treatises on astronomy.”

M. Rümker has sent a complete series of the meridian observations of the moon, made at the Observatory, Hamburg, between Jan. 3, 1845, and Feb. 16, 1848. The transits of the moon and moon-culminating stars have been generally observed over 13 wires, and the declinations of the stars and of the bright limb read off by 4 verniers. This and similar contributions are of great use, as affording accurate values of the errors of the lunar tables in reducing corresponding observations; and they are carefully preserved for that purpose.

The Rev. Temple Chevallier exhibited a volume, containing diagrams and observations of the Solar Spots, and expressed his intention of completing the same and presenting it to the Society.

Mr. Graham, of the Markree observatory, sends the following errata in Shortrede's logarithms:—

$$\begin{array}{lll}\text{Antilog. of } .58643, \text{ for } 8662, \text{ read } 8602 \\ \text{Sin. } 60^\circ 18' 25'' & 8756, & 8656\end{array}$$

## ROYAL ASTRONOMICAL SOCIETY.

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February 9, 1849.

No. 4.

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THE Annual General Meeting of the Society, Sir JOHN FREDERICK WILLIAM HERSCHEL, Bart., President, in the chair.

Before commencing the usual business of the meeting, the President rose and said :—

GENTLEMEN,—Before the proper and formal business of this meeting begins, I must call your attention to the bust which you have seen in our entrance-hall ;—It is that of our late beloved and respected president, Francis Baily, a name which will never be mentioned in this Society without calling up a lively recollection of all that is excellent in public, and amiable in private, character. When you trace, as you cannot but do, in that marble the faithful and charming reproduction of features we have so often seen in the place I now occupy, animated with the pure love of science, and with deep interest in the welfare of this Society, you will be surprised to learn that it is the production of an artist by whom these features had never been seen but in the faint reflexion of an engraving from his portrait, and in that painful memento which preserves the impress of a form from which the spirit has departed. When I name the eminent artist, however, who has wrought this triumph over time and oblivion (our celebrated sculptor, Edward Hodges Baily), your surprise will cease. It is an achievement familiar to his chisel.

The bust is presented to this Society by Miss Baily, the surviving sister of our late president. She has judged rightly in supposing we shall value it. No possession we have will be more precious in our eyes. Nowhere could a memorial of the kind be more appropriately placed than in the meeting-place of a public body with which his name and his fame are so largely identified, and of which he was so distinguished an ornament. We have now his picture and his bust—both excellent. What art can do to keep his memory fresh is done. It remains for us to shew that his spirit is not extinct among us.

I am sure you will enable me to respond as I ought to do to this touching and munificent gift of Miss Baily, who has requested

me to be her spokesman on this occasion ; and as there can be but one feeling on the subject, I shall call on the Astronomer Royal to embody that feeling in a motion of thanks.

Proposed by G. B. Airy, Esq., seconded by A. De Morgan, Esq.:—

That the cordial thanks of the Society be given to Miss Baily for this valuable present.

*Report of the Council to the Twenty-ninth Annual General Meeting.*

IN commencing this Twenty-ninth Report, the Council once more meet their constituents with congratulations on the state of the Society, and of the science which it is intended to promote. They trust that many years will elapse before either can be represented as stationary.

The Report of the auditors, subjoined, will shew the state of the finances :—

RECEIPTS.

	£	s.	d.
Balance of last year's account .....	131	18	9
1 year's dividend on £900 Consols .....	26	4	4
1 ditto on £2272 7s. 4d. New 3½ per Cents .....	71	14	0
On account of arrears of contributions .....	61	14	0
77 contributions (1848-49) .....	161	14	0
2 ditto (1849-50) .....	4	4	0
6 compositions .....	126	0	0
13 admission fees .....	27	6	0
7 first year's contributions .....	11	11	0
Sale of Memoirs .....	69	11	0
— Dr. Pearson's Astronomy .....	107	15	0
	<u>£799</u>	<u>12</u>	<u>1</u>

EXPENDITURE.

Mr. Barclay, for printing Testimonials .....	24	15	0
Ditto for printing Monthly Notices, &c. ....	120	11	7
Legacy Duty (Dr. Pearson's bequest) ....	21	11	11
Mr. Basire, engraver (do.) .....	14	4	0
Mr. Rumfitt, bookbinder (do.) .....	12	8	0
Taxes { Land tax and window duty, 4 quarters ...	8	7	3
{ Income and property tax, 4 quarters .....	1	9	2
	<u>9</u>	<u>16</u>	<u>5</u>
J. Williams, for 1 year's salary as Assistant-secretary .....	100	0	0
Ditto commission on collecting £443 15s. ....	22	3	6
Charges on books, and carriage of parcels .....	3	14	7
Postage of letters and Monthly Notices .....	24	0	11
Porter's and charwoman's work .....	13	12	2
Tea, sugar, biscuits, &c. for evening meetings .....	13	13	0
Coals, candles, &c. ....	12	18	6
Sundry disbursements by the Treasurer .....	23	17	3
Balance in the hands of the Treasurer (25th Jan. 1849) .....	382	5	3
	<u>£799</u>	<u>12</u>	<u>1</u>

The assets and present property of the Society are as follows :

	£	s.	d.
Balance in the hands of the Treasurer .....	382	5	3
1 contribution of 6 years' standing .....	£12	12	0
4 ——— of 5 ditto .....	42	0	0
1 ——— of 4 ditto .....	8	8	0
5 ——— of 3 ditto .....	31	10	0
11 ——— of 2 ditto .....	46	4	0
14 ——— of 1 ditto .....	29	8	0
	170	2	0

£900 3 per Cent Consols.

£2272 7s. 4d. New  $3\frac{1}{4}$  per Cent Annuities.

Unsold Memoirs of the Society.

Various astronomical instruments, books, prints, &c.

The stock of volumes of the *Memoirs* still in the Society's possession is as follows:—

Vol.	Total.	Vol.	Total.	Vol.	Total.
I. Part 1	50	IV. Part 2	178	XI.	257
I. Part 2	95	V.	192	XII.	269
II. Part 1	113	VI.	210	XIII.	288
II. Part 2	79	VII.	236	XIV.	472
III. Part 1	140	VIII.	222	XV.	265
III. Part 2	160	IX.	231	XVI.	305
IV. Part 1	165	X.	247		

The progress and present state of the Society, with respect to Fellows and Associates, is as follows:—

	Compounders.	Annual Contributors.	Non-residents.	Patrons, and Honorary.	Total Fellows.	Associates.	Grand Total.
February 1848 .....	121	132	72	3	328	36	364
Since elected .....	8	9	...	3	...	22	42
Deceased .....	—5	—1	—1	...	...	—1	—8
Resigned .....	...	—1	...	...	...	...	—1
Expelled .....	...	—9	...	...	...	...	—9
February 1849 .....	124	130	71	6	331	57	388

The instruments belonging to the Society are now distributed as follows :—

The *Harrison* clock,  
 The *Owen* portable circle,  
 The *Owen* portable quadruple sextant,  
 The *Beaufoy* circle,  
 The *Beaufoy* transit,  
 The *Lee* circle,  
 The *Herschelian* 7-foot reflector,  
 The *Greig* universal instrument,  
 The *Smeaton* equatoreal,  
 The *Cavendish* apparatus,  
 The Universal quadrant by Abraham Sharp,  
 The 7-foot Gregorian reflecting telescope (late Mr. Shearman's),

are in the apartments of the Society.

The Brass quadrant, said to have been *Lucuille's*, is in the apartments of the Royal Society.

The Standard scale is in the charge of the Astronomer Royal, with the consent of the Council, to be employed in the formation of a new Standard Measure, under the direction of the Standard Committee.

The remaining instruments are lent, during the pleasure of the Council, to the several parties undermentioned, viz. :

The *Fuller* theodolite, to the Lords of the Admiralty.  
 The *Beaufoy* clock, } to the Royal Society.  
 The two invariable pendulums, }  
 The *Wollaston* telescope, to Professor Schumacher.  
 The Variation transit (late Mr. Shearman's), to Mr. J. Rees.  
 The other *Beaufoy* clock, to Mr. J. Drew.

Since the last Annual Report, the bequest of Dr. Pearson, consisting of the unsold copies of his well-known work on *Practical Astronomy*, has come into the final possession of the Society. All the complete copies, upwards of one hundred, have been disposed of, either to the Fellows or to the public, at a price fixed by the Council. The copperplates remain, together with a large number of copies of the first volume containing the tables.

Among the donations made to the Society, most especial notice must be taken of one which is presented to-day. It is a bust of our late President, Francis Baily, presented by his sister, Miss Baily, and executed by his eminent namesake, Mr. E. H. Baily, who, with the assistance of the portrait which hangs in this room, and a cast of the head taken after death, has produced a specimen of art worthy of his own fame, as well as of that of our late Presi-

dent. In returning hearty thanks to Miss Baily for this very valuable addition to our memorials of her brother, the Council feel that there is no occasion to say anything on the vital obligations which the Society owes to him, from the first day of its career to the last of his. These obligations are not such as need be recalled by an anniversary, or recapitulated on the occasion of receiving a token of consideration from his family: they are remembered in the daily routine of our business, where they will long be felt. But the needlessness of the gift in this point of view increases its value, and also our gratitude to the donor; though few words will serve to record its receipt, and to express our thanks in fitting terms.

The Council have not thought it advisable, as yet, to take any steps for the printing of the library catalogue. The heavy expenses incurred in printing matters of more immediate importance have made it prudent to postpone this one for a time; but the Council have not lost sight of it, and hope to feel able to commence the impression in a short time.

The Fellows will remember that at a Special General Meeting, held after the last Anniversary Meeting, it was referred to the Council to consider whether it would not be proper to take legal means for the recovery of the arrears due to the Society. The Council gave this subject their earliest attention; and after duly weighing the considerations on both sides, came to the conclusion, that the Society should be advised not to proceed at law, but to expel the defaulters in the usual way. This was accordingly done at a Special General Meeting, held on the 14th of April. The Council much regret that this Society, in common with others, sustains loss from the want of consideration, to say no worse, of those who are content to allow pecuniary engagements for the promotion of Astronomy to be entered into under the guarantee of the Annual Subscriptions, and leave their portion of that guarantee to be made good by others. At the same time, it is gratifying to state that this Society is high among scientific associations as to the promptitude with which its dues are paid.

The Special Meeting last alluded to had a much more pleasant duty to perform, in addition to the one above recorded. The Council proposed to it the election of three Honorary Members: His Majesty the King of Denmark, who resembles his predecessors in being a promoter of Astronomy; His Grace the Duke of Northumberland, who carried into effect with noble liberality his predecessor's engagement to print Sir John Herschel's great work on Southern Astronomy; and Baron Von Senftenberg, whose private observatory does him and his adopted country honour. It is needless to add that the Meeting unanimously adopted the proposal of the Council, and that these three worthy names are now on our list.

The intention of the Council to consider the state of the list of Associates, mentioned in the last Annual Report, led to the pro-

posal and election (on the 12th of May) of the following twenty-one gentlemen :—

Dr. P. H. L. von Boguslawski, Breslaw.	M. K. C. Hencke, Göttingen.
Dr. C. Bremiker, Berlin.	M. Laugier, Paris.
Dr. A. L. Busch, Königsberg.	Professor J. H. Mädler, Dorpat.
Dr. Thomas Clausen, Dorpat.	M. Mathieu, Paris.
Professor A. Colla, Parma.	M. V. Mauvais, Paris.
M. H. D'Arrest, Berlin.	Dr. C. A. F. Peters, Pulkowa.
M. Daussey, Paris.	Dr. A. C. Petersen, Altona.
M. H. Faye, Paris.	M. K. C. Rümker, Hamburg.
Dr. J. F. G. Galle, Berlin.	M. Otto von Struve, Pulkowa.
Dr. B. Goldschmidt, Göttingen.	M. Max. Weisse, Cracow.
Professor K. Knorre, Nicolajew.	

This list, the Council can truly observe, was no indiscriminate sweep, but the result of a deliberate discussion of the astronomical claim of each and every person named. And they take some blame to themselves for remissness, in having allowed the question of additions to this list to remain undiscussed until the progress of astronomy had to be acknowledged to more than a score of distinguished cultivators. But at the same time they feel that they have some excuse in the difficulty of procuring, at the requisite time, that precise information on the labours of continental astronomers which will warrant a step that is never taken on any thing less. Since the last-mentioned period, the Council has had the pleasure of procuring from the Society the addition to the list of the name of Mr. Bond of Cambridge (U.S.), the co-discoverer, with Mr. Lassell, of the eighth satellite of *Saturn*.

Among the losses by death, the Council have to regret those of Mr. Hoyer, Mr. de Berckem, General Hodgson, Mr. T. G. Taylor, Mr. Gilby, the Marquis of Bute, and an associate, Father De Vico.

Mr. JACOB HOYER was one of the members of the Mathematical Society. He was born in June 1797, and died February 23, 1848. Both his parents were Norwegian, and came to England a few years before his birth. At the age of about fifteen, the support of his parents devolved on him owing to his father's loss of sight, and by incessant labour he was enabled to maintain them respectably and to advance himself in life. He was an ardent lover of science, and collected a valuable library; but an ill state of health, brought on by overwork in his youth, prevented his making any attempt to promote knowledge by his own investigations.

HENRY VINCENT DE BERCKEM was born in 1804. He followed his father's profession, and passed his life on the Stock Ex-

change. He was elected a Fellow of the Mathematical Society before he was twenty-one years old, and continued a zealous member of that body until it merged in this Society in 1845. He was well versed in mathematics and in the theory of music.

JOHN ANTHONY HODGSON, eldest son of George Hodgson, Esq., was born at Bishop Auckland, in the county of Durham, July 2, 1777. He received the principal part of his school education at the grammar school in the city of Durham, under Dr. Britton: and was for some time designed to follow the profession of the law. The employment, however, was found to be by no means adapted to the natural bent of his mind; and, at the expiration of his engagement, he availed himself with eagerness of an opportunity of entering the military service of the Honourable East India Company. In the year 1799, at the age of twenty-two, he embarked as a cadet for India, and in May 1800 became lieutenant in the 10th Regiment of Native Infantry.

Until this time his attention had not been directed either to the Oriental languages or to general science. But he now devoted himself with assiduity to those studies, and especially to practical astronomy.

The earliest of his observations (an immersion of *Jupiter's* first satellite, October 23, 1812, observed at Setapoor cantonments, Oude) is printed in *Mem. Hist. Soc.* vol. ii. p. 344.

In the year 1817, being then captain in the 10th Regiment, B. N. I., he was selected with Lieutenant Herbert to conduct a survey of the sources of the rivers Ganges and Jumna, and to determine the heights and positions of the principal peaks of the Himalayan mountains.\*

In conducting this survey great difficulties were encountered, both from the deficiency of those means which are usually considered essential, and from peculiar physical obstacles. The instruments were exposed to all the casualties of a long voyage, a long journey, and much rough usage. Hence the barometers and thermometers were frequently found broken on their arrival at their destination, and not unfrequently, before a barometrical measurement could be made, it was necessary to fill the tube.

The progress of the survey was much retarded by natural impediments. For some time the operations were suspended after the early period of every day, in consequence of avalanches of snow and rock being hurled into the valley as the heat of the sun melted the snow; and a passage was often to be forced through many obstacles, and along the face of precipitous rocks.

There was, especially, one occurrence so different from those which usually cross the calm path of scientific investigation that it deserves especial notice.

It is thus recorded in the Journal of May 26, 1817.†

\* Asiatic Researches, vol. xiv. pp. 60, 153, 187.

† Asiat. Trans. vol. xiv. p. 97.

"The path to-day was of the worst description, and is on the whole, I think, the most rugged march we have hitherto had, though there are not any long ascents. Nothing can be more unpleasant than the passage along the rotten ladders and inclined scaffolds by which the faces and corners of the precipice near Bhairog'hátí are made. The rest of the way lies along the side of a very steep mountain, and is strewn with rocks. The ruins of the snowy peaks, which are on all sides, were very grand and wild . . . . . Too much tired to attempt to boil mercury in the tubes to-day. At night, having prepared the instruments to take the immersion of one of *Jupiter's* satellites, we lay down to rest, but between ten and eleven o'clock were awakened by the rocking of the ground; and on running out saw the effects of an earthquake, and the dreadful situation in which we were pitched, in the midst of masses of rock, some of them more than a hundred feet in diameter, which had fallen from the cliffs above us, and probably brought down by some former earthquake.

"The scene around was shewn in all its dangers by the bright moonlight, and was, indeed, very awful. On the second shock, rocks were hurled in every direction from the peaks around to the bed of the river, with a hideous noise not to be described, and never to be forgotten. After the crash caused by the falls near us had ceased, we could still hear the terrible sounds of heavy falls in the more distant recesses of the mountain.

"We looked up with dismay at the cliffs overhead, expecting that the next shock would detach some ruins from them. Had they fallen we could not have escaped, as the fragments from the summit would have flown over our heads, and we should have been buried by those in the middle. Providentially there were no more shocks that night.

"In the morning we removed to the left bank of the river . . . . We had the curiosity to measure trigonometrically the height of the cliff at the foot of which we were during the shock, and found it to be 2745 feet."

The height of the station above the level of the sea appeared by barometric measurement to be about 10,300 feet.

Notwithstanding these and other natural obstacles, the enterprising travellers persevered, and on the 31st of May, 1817, reached the point where the Ganges first issues from beneath a vast bed of snow, surrounded by gigantic peaks, in latitude  $30^{\circ} 56' 6''$  north, a spot to which there is no record that any person before had penetrated.\*

The operations for the survey of the peaks of the Himalayan range were carried on upon a vast scale. One of the principal stations was at an elevation of 12,000 feet, in the region of perpetual snow: the distances of some of the peaks from the stations at which they were observed exceeded 150 miles; and above twenty of those peaks attain an elevation between 20,000 and 27,000 feet, including the loftiest known mountain in the world.

\* Asiatic Trans. vol. xiv. pp. 118, 171.

The results of these labours have become well known. Four sheets of the Atlas of India were made from his trigonometrical surveys, and under his immediate superintendence.

In the great geographical work of Ritter, General Hodgson's authority is appealed to as definitively fixing the positions which he surveyed.

The principal characteristic which marks General Hodgson's surveys is his perseverance under difficulties of no ordinary kind, and his great fertility of resource. His astronomical and geodetical observations were made with a delicacy and accuracy which will fully bear a comparison with those executed under far more favourable circumstances; and in every emergency he availed himself of all the means suggested by sound philosophy and practical common sense.

There is a series of transit observations\* made under his superintendence at Calcutta, and a series of magnetic observations† made by him at the same place.

In May 1821, General Hodgson was appointed Surveyor-general of India, but not confirmed. In 1826 he was again appointed, and held that office till 1827, when he returned to England.

On his return to Europe, he resided for some time in the city of Durham; and in June 1842, in consideration of his distinguished character as a man of science, he was admitted to the honorary degree of M.A. in the University of Durham.

In 1845, having then the rank of Major-general, and being Colonel of the 14th Regiment of Bengal Native Infantry, he was appointed to the command of the district of Rohilcund, and died at Umballah on the 28th of March, 1848, in the 71st year of his age.

The following papers by Major-General Hodgson have been published in the *Memoirs* of this Society.

- Vol. II. Observations of *Jupiter's* Satellites, made at Chouringhy. Observations of ditto, made at Futty Ghur, on the Ganges.
- Vol. III. Observations at Calcutta, comprehending, 1. Transit of *Mercury*, Nov. 4, 1822. 2. Occultations of Stars, March and April, 1823.
- On the Mode adopted for determining the Time of the Observations of *Jupiter's* Satellites at Futty Ghur.
- Register of certain Observations of the Eclipses of the Satellites of *Jupiter* made in Hindostan and in the Burmese dominions, between July 18, 1795, and April 11, 1827.
- Observations of Transits of the Moon's Limb and certain Stars, from Nov. 18, 1826, to March 20, 1827, at Calcutta.

\* Astr. Soc. Trans. vol. iii. part ii. p. 358.

† Asiatic Researches, vol. xviii. part ii. p. 1.

THOMAS GLANVILLE TAYLOR, late Astronomer to the Honourable East India Company at Madras, was born at Ashburton, Devonshire, November 22d, 1804, about a year before his father, Thomas Taylor, was appointed assistant to Dr. Maskelyne at the Royal Observatory. He remained at school until he was fourteen, when his father (who had previously intended to bring him up as a surgeon) was induced, on Mr. Pond's suggestion, to devote him to astronomy. About the beginning of 1820 he was engaged as a supernumerary at the Royal Observatory, and was placed on the establishment as a regular member in August 1822, when the number of assistants (by Mr. Pond's exertions) was permanently increased to four. Mr. Taylor's principal duty was to take charge of the transit observations at night.

Soon after this time he computed the orbit of a comet, as well as we recollect, by La Place's method; but we are unable to supply the exact date, or to refer to the proper authority.

Mr. Taylor gave every aid in his power to Colonel, then Captain, Sabine, when he was engaged on "*his experiments for determining the difference in the number of vibrations, made by an invariable pendulum, at the Royal Observatory at Greenwich, and at Mr. Browne's house in Portland-place, where Captain Kater's experiments were made.*" This assistance is apparent throughout the memoir, and was very handsomely acknowledged by Colonel Sabine (*Phil. Trans.* 1829, p. 85). When the same accomplished observer was engaged on his still more difficult and delicate investigation, respecting "*the reduction to a vacuum of the vibrations of an invariable pendulum,*" (*Phil. Trans.* 1829, p. 207) he again acknowledged, in fitting terms, "the valuable assistance of Mr. Taylor," who, besides furnishing the clock rate and error, observed a considerable number of sets in the pendulum series. We need not ask for a higher testimony to Mr. Taylor's skill and powers of manipulation in the nicest operations.

About this time he was engaged, at his leisure hours, in assisting Mr. Groombridge with the reduction of his *Catalogue of Stars within 50° of the North Pole*; and though only a small portion of this task was accomplished by him, the duty was faithfully and efficiently discharged.

The zeal and ability of Mr. Taylor was so well approved to Mr. Pond, then Astronomer Royal, that he recommended him to the Honourable East India Company as a proper person for the important office of Director of the Company's Observatory at Madras. Mr. Taylor was accordingly appointed in the spring of 1830: his astronomical observations have since that time been regularly published at the expense of the Company, and extend at present to five volumes.

In 1840 Mr. Taylor visited England, and returned to Madras in the following year. Two or three years afterwards he met with a severe accident while on a visit to the observatory of Trevandrum—a fall, occasioned by his extreme shortness of sight—from which he never perfectly recovered. His own failing health, and

the anxiety he felt with respect to his daughter's illness, who was then in England, brought him back to his native country. He arrived on the 4th of April last, in time to receive the last breath of his child, who expired next day. He still entertained sanguine hopes of his own recovery, and spoke with cheerfulness and interest of the publication of his last volume of Observations, but his weakness and extreme emaciation continued to increase, and ended his life on May 4, 1848. He has left a widow and three sons.

Besides the Madras *Astronomical* Observations, Mr. Taylor made a very extensive series of *Meteorological* and *Magnetic* Observations, and also directed and superintended other similar observations in different parts of India, most of which have been published by the Company. Though these works have been liberally distributed by the Honourable Company to all proper applicants, they are probably less known than they deserve to be, from want of sufficient notoriety. Mr. Baily made the Madras catalogues of fixed stars the basis of his great catalogue, which is commonly known as the Catalogue of the British Association, and devoted a column in that work to Mr. Taylor's nomenclature. We do not know whether any attempt has been made to appreciate the exactness of the determinations; but the observations are so numerous, and the list of stars so extensive, that such a research would appear feasible enough, and the result of great practical utility. For many stars Mr. Taylor's authority is probably the best, but some measure of the probability of his errors is very desirable.

A memoir on the longitude of Madras, derived by Mr. Taylor from a comparison of his transits of the moon with those taken at Greenwich, Cambridge, &c., will be found in vol. xvi. of the Society's *Memoirs*. This is a supplement of a former memoir, vol. xii., on the same subject, from data of the same kind, by Mr. Riddle. The longitude of Madras is of great importance in geography and navigation, as its meridian is a secondary meridian for India and for the Eastern Seas. There is also in vol. x. a short paper by Mr. Taylor on the right ascensions and declinations of Halley's Comet, near the time of opposition in 1836, from observations made at Madras.

It is understood that the Observatory at Madras, while under Mr. Taylor's direction, rendered efficient assistance to the vessels which touch at that important point. On one occasion, at least, he gave timely notice of a coming storm (from meteorological indications), which saved much shipping from imminent danger. Nowhere can such aids be more required than at Madras.

The Society has lost in Mr. Taylor a zealous practical astronomer, and a sincere friend to the body.

THE REV. WILLIAM ROBINSON GILBY, son of John Gilby, Esq., of Winterton, Lincolnshire, was born in 1789. After remaining for several years at Shrewsbury School, then taught by the celebrated Dr. S. Butler (afterwards Bishop of Lichfield), he was admitted a

pensioner of Trinity College, Cambridge, in 1805. His university course was very successful. He was elected scholar in his freshman's year, 1806; was in the first class at each annual examination, took the degree of seventh wrangler in 1809, and was elected fellow in 1811.

For a few years he studied the law with assiduity, and gave promise of great eminence in that profession; but his health failed, and he entered the church about 1819. He married in 1820, and in 1823 was appointed by Lord Chancellor Eldon to the living of St. Mary with St. Nicholas in Beverley. In 1832 he resigned this living, and made a tour on the Continent. Soon after his return home he built a small observatory, which he furnished with a very beautiful altitude and azimuth circle by Troughton and Simms, the altitude circle being 2 feet in diameter and originally divided. Collimating telescopes with spirit-levels were applied, perhaps for the first time in England, to this instrument, as an additional mode of adjustment. A transit-clock by Dent, and chronometer, &c. completed the equipment.

Mr. Gilby paid a good deal of attention to observing, and corresponded with one of our fellows on the subject of certain instrumental reductions; but we are not acquainted with the particulars of his researches. It was, perhaps, imprudent, in a man so delicate, and who was also greatly occupied by his magisterial duties, to undertake such a troublesome instrument,—one which, so far as we remember, has proved almost unfruitful in every amateur's hands, except in those of Mr. Pond. It is most likely that, when he had mastered the instrument, he found the pursuit too laborious and the night exposure too great. This was to be lamented, for as Mr. Gilby was a good mathematician, and very energetic in all his undertakings, he would have done good service in a lighter department of astronomy, while he would have exposed his health less.

In the latter years of his life, Mr. Gilby's health was such as to prevent much active employment. A slight imprudence, in exposing himself to a damp day, brought on an attack from which he never rallied; after a few days' illness, he died on February 23d of last year.

JOHN CRICHTON STUART, second Marquis of Bute, died most suddenly at his seat, Cardiff Castle, on the 18th of March, 1848, after having entertained a party of friends at dinner. He was born on the 10th of August, 1793, and was consequently in the fifty-fifth year of his age, twenty-one of which he had been a member of this Society. In 1803, by the death of his maternal grandfather, he succeeded to the earldom of Dumfries; and in 1814, by that of his paternal grandfather, the first Marquis of Bute, he inherited that dignity.

Lord Bute, though afflicted with a defective vision, was of very active, business-like habits, and performed his several duties with great diligence, and mostly judicious conduct. His greatest undertaking was the construction of the grand floating docks at

Cardiff, a vast harbour, which affords the most ample accommodation for hundreds of ships to avail themselves of the mineral riches of Glamorgan at all times and seasons. The Marquis expended at least 400,000*l.* upon this important work ; and his munificence has not only already enriched the town, but must, inevitably, from the fitness of the site and capacity of the float, fully repay its costs with interest in the end. The full energies of the project have certainly been procrastinated by litigation and impolitic measures, but the plan and object are too useful to be long repressed.

FRANCIS DE VICO belonged to the noble Italian family of that name, and was born at Macerata in the march of Ancona on the 19th of May, 1805.

He was educated at the college of Urbino, and although the eldest son, with brilliant prospects of advancement in the world, he evinced such a decided inclination for a religious life that he was admitted a member of the Society of Jesus in December 1823.

He distinguished himself in his theological studies, and having also shewn a peculiar aptitude for astronomical science was associated with Signor Dumouchel, the then Director of the Observatory of the Collegio Romano.

On the death of Signor Dumouchel, in 1839, Professor De Vico succeeded him as Director of the Observatory.

De Vico was for some time a professor of the higher mathematics in the Roman college, and afterwards became the astronomical professor, in which distinguished situation he continued for many years.

Being ever indefatigable in the pursuit and advancement of astronomical science, besides the two members of the order who were his regular assistants in the observatory, he associated as aids in his astronomical labours several young men of marked talent whom he had previously instructed for that purpose under his immediate direction.

Professor De Vico wrote and published numerous memoirs upon astronomy and other branches of physical science, many of which are highly esteemed. His observations of the Spots of *Venus*, and of the Rotation of that planet, and his observations of the Rings of *Saturn*, are well known to astronomers, and much admired.

He had the honour of discovering six comets :—

The First	on	August 22, 1844.
„ Second	„	Feb. 26, 1845.
„ Third	„	Jan. 24, 1846.
„ Fourth	„	Feb. 20, 1846.
„ Fifth	„	July 29, 1846.
„ Sixth	„	Sept. 23, 1846.

These discoveries following each other so closely, and made at a period when many astronomers of practised ability were devoting

much attention to cometary phenomena, added considerably to the already well-deserved fame of De Vico.

The King of Denmark's Gold Medal, granted to the first discoverer of a telescopic comet, was awarded to him four times in 1846 for the comets he discovered in that year.

He also obtained the prize of Lalande, which is awarded every year by the French Academy of Sciences, on Lalande's foundation, "to the maker of the most interesting observation, or the author of the memoir which has most advanced astronomy." De Vico was one of the forty members of the Italian Society of Science.

He possessed considerable talent in musical composition, especially in sacred music, and he found leisure, amidst his astronomical labours to form and direct a body of singers for the Papal chapel which gained the admiration of connoisseurs in that art.

When the Society of Jesus was sent away from Rome in 1848, it was the universal desire of the city, including even the adversaries of the Jesuits, that Professor De Vico should remain as Director of the Observatory, but he would not consent to this, and departed secretly from Rome.

He then visited Paris, and came to England in the summer of 1848, when his talents and agreeable, unassuming manners gained him many friends among men of science.

From England he proceeded to the United States of America, in furtherance of some scientific labours. He soon returned to England, and shortly afterwards was attacked with typhus fever, brought on by fatigue and anxiety of mind, of which he died on the 15th of November, 1848. He is interred in the cemetery at Chelsea belonging to the Roman Catholic chapel.

The *Monthly Notices* have now been before the Fellows of the Society long enough to shew the design and effect of the alterations mentioned in the Annual Report of last year. It is evident that their contents are larger and more varied, and, therefore, that the Fellows receive a somewhat better return for their contributions. Probably the expense will not *much* exceed that under the former arrangement; but it must not be concealed that the printing and postage of the *Monthly Notices* form one of the heaviest items in our yearly expenses. On the other hand, it is certain that the ephemerides which are contained in the *Notices*, and the excellent observations thereby obtained, have been very useful to astronomy and very creditable to our self-supporting Society.

For the ephemerides, the Society is indebted to Messrs. Adams, Graham, Hind, and Pogson, and also to our excellent friend and associate, Professor Schumacher, the active promoter of all astronomical inquiry. The observations, in general, are transmitted in so clear a form that they can be handed at once to the printer; those, for instance, from Cambridge, Markree, Liverpool, &c. may be taken as models. In some cases, a little more care and a little attention to the forms now established in the *Monthly Notices*,

would save a good deal of unnecessary trouble. It is also very desirable that when there is any peculiarity in the instrument or mode of observing, this should be very fully explained; an oversight in this respect is not uncommon, even in practised observers, it is so easy to suppose that to be known to another which is before your own eyes. If the vexation which a little carelessness in this respect gives were fully appreciated, there would soon be no cause for complaint, and some time and expense would be saved.

A short account of the course pursued by the Council with respect to the *Memoirs* presented to the Society may be satisfactory. All those papers which are deemed by the Editor of the *Monthly Notices* to belong to his department are printed as soon as possible, without waiting for their announcement to the Council. The heavier papers are announced to the Council, and read at the evening meetings; an abstract is published as soon as it can be furnished. In the *Monthly Notices* there is no attempt made to alter or correct the *sense* of any communication; if it is tolerably ingenious, and not positively absurd, the substance is printed in the author's words, compressing the language as much as possible, and striking out what seems irrelevant. If a paper appears unworthy of attention (and the Society receives two or three such every session) the nature of the contents is briefly reported to the Council, and a Committee is appointed, to whose judgment the paper is referred. In all cases, the papers, whether printed in the *Monthly Notices* or not, are referred to a Committee to decide whether they shall be printed in the quarto *Memoirs*, and a ballot is taken by the Council upon the report of the Committee. When a paper consists of observations or ephemerides, it is referred (with all papers of a similar kind) to an observation committee, who hold their meetings at the end of the session. In this way it is hoped that every communication is carefully examined, and that the Society receives the whole of the useful information presented to it, either in the 4to. or the 8vo. publication. The lucubrations of those authors who treat every science, unknown to themselves, as a new science, and who conceive that astronomy is yet to be *discovered*, or rather *guessed*, without geometry, or analysis, or dynamics, are either deposited peacefully in the archives, or returned to their writers at the discretion of the Secretary.

About eight sheets of the seventeenth volume of the quarto *Memoirs* are printed, and it is hoped that the whole will be completed in a few days.

Another small planet has been added to our list during the past year. It was discovered on the 26th of April, by Mr. A. Graham, Director of Mr. Cooper's Observatory, Markree Castle. A rigorous search for planets had been commenced some time previous, and is still pursued agreeably to a plan which has been already described in the *Monthly Notices*, and which we may reasonably hope will lead to the detection of other planetary bodies. This new member of the system has received the name *Metis*, with

an eye and star for a symbol. The period of revolution is 1346 days, or almost identical with that of *Iris*. The planet was never brighter than a star of the 9-10th magnitude, and, towards the end of its first appearance, was very much fainter. It was followed, at Cambridge and Berlin, until the commencement of August. Mr. Graham has calculated an ephemeris for the approaching reappearance, which, however, takes place under somewhat unfavourable circumstances. *Metis* approaches very closely to the orbits of the planets *Vesta* and *Flora*.

A remarkable discovery, that of an additional satellite of *Saturn*, was made last year, almost at the same moment, by Mr. Lassell, at Liverpool, and our associate, Mr. W. C. Bond, of Cambridge, U.S. Full accounts by the respective authors will be found in the *Monthly Notices*, and the peculiarity of the discovery is considered by the President in his speech.

Since the last Anniversary of the Society two new Comets have been discovered, both at Altona, and the celebrated Comet of Encke has reappeared.

On the night of August 7th, Dr. Petersen, assistant astronomer to our distinguished Associate, Professor Schumacher, detected a telescopic comet in *Auriga*, which was observed pretty generally until the 25th of the same month. It was at no time visible to the naked eye. Parabolic elements represent the observations within their probable errors. The inclination of the orbit to the ecliptic exceeds  $85^{\circ}$ .

The second new comet was found by the same astronomer on the evening of October 26th, in the constellation *Draco*. It was then tolerably bright, with a strong condensation resembling a stellar nucleus near the centre of the nebulosity. Shortly before its disappearance beneath our horizon, in the middle of January, it was visible without the telescope, exhibiting a short tail and presenting the appearance of a hazy star of the fourth or fifth magnitude. M. d'Arrest has calculated the elements from a wide extent of observation, but finds no indication of ellipticity. As in the case of the first comet, the orbit is very highly inclined to the plane of the ecliptic: at the descending node, which occurred three weeks before the perihelion passage, the comet approached our orbit within 0.025 of the earth's mean distance. It will be still visible to astronomers in the southern hemisphere for some time.

The reappearance of the Periodical Comet of Encke was detected on the 27th of August, by Professor W. C. Bond, of Cambridge, United States, with the great refracting telescope recently erected at that place. Professor Challis saw it on the 2d of September; on the following night it was found at Mr. Bishop's Observatory; and on the 4th at Berlin, by Dr. Galle. The comet was generally observed during the month of October, and Professor Bond was fortunate enough to obtain observations after the perihelion

passage and close approach to the planet *Mercury*. It presented much the same appearance as in 1828 and 1838, the general outline of the comet being elliptical, with a very sensible condensation of light on the side near the sun.

The late transit of *Mercury* was very extensively observed. At the Royal Observatory it was observed with eight telescopes, three of which were employed in the method of casting an image of the sun upon a screen of white paper. Allusion is made to these observations only for the sake of recording one singular discordance. At seven of the telescopes the planet was seen to enter upon the sun's limb without any distortion; at the eighth, in which the image was thrown upon a screen, the planet was much distorted at entrance, its limb being for some time connected with the sun's limb by several black ropes, similar to those which have been remarked in transits of *Venus* and eclipses of the sun. This was seen by several observers. It is to be remarked, that this telescope (the Sheepshanks telescope of the south-east equatoreal) is the largest, and, upon the whole, the best that was used, and that the image of the sun was the brightest; but that it was disturbed much more by atmospheric undulation than the image formed by any of the other telescopes. It would seem possible that this strange phenomenon may have some connexion with the same irregular refraction which produces the notched and serrated appearance of the sun's limb.

In the Report of last year, allusion was made to a proposed change in the meridional instruments of the Royal Observatory. The change specified (the substitution of a transit-circle, with a telescope of 8 inches aperture, for the transit instrument and mural circle) having received the approval of the Board of Visitors and the sanction of the Board of Admiralty, is now in progress. Jones's Cape circle, having been made as efficient for observation as its faulty division permits, was used for a time, while Troughton's circle was shifted to an eastern wall of a building, where a temporary shed was erected over it, and where it is still in use. The circle-room was entirely taken down, the stone-piers were removed, and (the preliminary steps having been taken while the pier was in its ancient position) one of them was bored with the holes necessary for the arrangement of microscopes and illuminators proposed by the Astronomer Royal. The piers were then built up in their new positions, and the new transit-circle room was built over them. It has been necessary to extend the room to a length of 35 feet in the meridional direction; and this consideration alone made it almost imperative to adopt a construction which the Astronomer Royal had found convenient to adopt in smaller observatories, namely, to place the roof with its ridge north and south, and with the observation-opening along the ridge and in the end-walls. These preparations are very nearly completed. In the mean time the preparation of the instrument (the massive parts of which are

entirely of cast-iron) has been advancing under the anxious superintendence of Mr. C. May (of the firm of Ransomes and May, engineers, of Ipswich). The axis, including the central cube and the pivots, is formed in two pieces only, the pivots being made hard by a process well known to ironfounders called *chilling*, a process which (in this case) secures the inestimable advantage of forming the pivot in the same flow of metal as the rest of the axis, while its surface is as hard as hardened steel. The casting of these halves of the axis (a very complicated piece of work) has been successfully accomplished, and they are now to undergo the operations of planing, turning, and (for the pivots) grinding, by an operation which gives the same certainty of circularity as the ordinary process of turning. Within the axis will be fixed a collimating telescope (to be viewed, when necessary, by an external telescope), by which any error in the form of the pivots will be detected and measured. The end of the telescope has been cast, and, such is the skill of the founders, its weight scarcely exceeds that of a tube of stout sheet-iron. The circle is in preparation. The microscope-holes through the pier are so placed in the surface of an imaginary cone, that, though the microscopes will read the divisions on a circle 6 feet in diameter, the eye-holes will be in a circle of only 2 feet in diameter (an arrangement which will very much diminish the labour of the assistants). The illuminating-holes are so placed in the surface of another imaginary cone that one lamp will illuminate the divisions under all the microscopes, without any intermediate reflector. As the axis of each illuminator is necessarily inclined to that of its corresponding microscope, it is necessary that the surface of the divided limb be so inclined that the rays of light passing down the illuminating-hole may be reflected by it up the microscope, and therefore the circle must be *dished*. Arrangements for effecting this object are made by Mr. May. The form of the instrument will not admit of reversion or of the application of a level in the ordinary way, and it has become necessary to determine the error of collimation by two fixed collimators, admitting of adjustment on each other (a plan which also gives the great advantage of perpetual reference to two meridian marks), and to determine the error of level by observation of the wires by reflexion, or by the observation of transits of stars by reflexion. In these, and some other points, several novelties have been introduced, but not one has been introduced except where the magnitude of the instrument, or constructions required in the first instance by its magnitude, imperatively demanded it. In this respect, perhaps, the plan of the instrument may be interesting to the members of the Society, as shewing the direction which probably will be taken by the changes in the construction of instruments, arising from the increased magnitude which we may expect to attend the already increased facilities for procuring large object-glasses. A model of the instrument, shewing the form originally proposed for it by the Astronomer Royal, and from which, in fact, no deviation whatever has been made (except in some trifling dimensions, not affecting the

principle of any part), as soon as it has ceased to guide the workmen will be placed by the Astronomer Royal at the service of the Royal Astronomical Society, if they deem it worthy of their acceptance.

The Society have already been acquainted with the general fact that an altitude and azimuth instrument, of remarkably massive and firm construction, has been mounted at the Royal Observatory, for the express purpose of observing the moon on every day on which it is at any time visible. We cannot but consider this as the most important innovation that has been introduced at the Royal Observatory for many years, whether we remark in it the recognition of the one object for which the Observatory was originally built as that which ought still to be considered its principal object, or whether we consider the principles of firmness and absence of adjustment on which the instrument itself is constructed. In regard to the increase in the observations, it may be generally stated that the number of days of observation has been nearly doubled, and that numerous observations are now made on a full quadrant of the moon's orbit in which it was impossible to observe her before. In regard to the instrument itself, there have been the usual difficulties attending every new construction. At first the observations were somewhat deranged by the use of too heavy counterpoises for the horizontal axis; at a later time the derangements of the levels were so serious as to shew that the English construction of levels must be abandoned, and that the modern German construction (in which the glass tube is supported in Y's without plaster or any other fixing substance) must be substituted. This change was not made in all the levels, but in those which had, by their discordance, given the greatest trouble; and it is worthy of remark, that these levels are now the steadiest of all. It is much to be wished that English instrument-makers should adopt this construction generally, or, at least, in all cases in which levels are permanently attached to instruments. After this, a cause of vexation was discovered, to which nothing analogous (so far as we know) has ever been remarked. The existence of personal equation in the observation of transits has long been known. It has lately attracted much greater attention than it formerly did, and, for some years past, the examination into the personal equations of the several assistants has formed an important part of the introduction to each of the annual volumes of Greenwich Observations. But the fact now discovered, and established on most certain evidence, is, that the personal equation is not the same for the moon and for stars, the difference amounting to nearly four-tenths of a second of time, and that in the instance of the assistant whose observation is believed to be anomalous, the moon is observed (with reference to the stars) too early by this quantity. The error affects equally the first limb and the second limb of the moon, so that the diameter of the moon is not affected. On applying a correction for this, the results of the observations are made as accordant as those of meridional observations; and the Astronomer Royal considers that the difficult practical problem which he had proposed to himself, of making

extrameridional observations as accurate as meridional observations, is completely solved. Lately a new circumstance has attracted attention. The relation of the azimuth-zeros determined by high and low stars, and the relation of the errors of tabular zenith distances on the east and on the west sides of the meridian, agree in indicating that the arc of longitude between the altitude and azimuth instrument and the transit instrument differs from the geodetic arc by one-tenth of a second of time. In order to verify this very curious circumstance (which may, in fact, arise merely from an error of personal equation), and to give greater accuracy to the observations generally, the internal arrangements of the observatory have been completely remodelled, in such a manner that the personal equations of the observers who are employed in turn on the altitude and azimuth instrument may be accurately determined by continual interchange of observations with the transit instrument.

The 25-foot zenith tube of the Royal Observatory, having been found to give results of no greater accuracy than those obtained in the ordinary course of observations with the mural circles, and having been the cause of much inconvenience, from its local position and other circumstances connected with its observations, has at length been dismantled. Allusion has been made, in former communications to the Society, to a singular construction proposed by the Astronomer Royal, in which the micrometer will be carried by the frame of the object-glass, and a trough of mercury will be placed at a distance below it equal to half the focal length of the object-glass. The incessant work of preparation of new instruments, and other occupations at the Royal Observatory for some time past, have prevented the taking of any steps for the mounting of the new zenith sector; but it is now in the hands of Mr. Simms, and will probably be in action in a short time.

In the last Report of the Council, an ample account was given of the Reductions of the Greenwich Lunar Observations from 1750 to 1830, then nearly prepared for publication. Since that time the work has been published in two quarto volumes; and the Council are confident that it may be exhibited to the world as one which for magnitude (as directed to a special object) and for general accuracy has scarcely ever been equalled. Already this work is beginning to produce its fruits. The volume of our *Memoirs* now in the press contains a communication by the Astronomer Royal, exhibiting the principal deductions from those reduced observations, as applying to the mean motions of the moon and of the various arguments on which her inequalities depend, and to some of the coefficients of the largest inequalities, either those which must in the nature of things be deduced from observation only, or those which ought to be correctly computed by mathematical process on the pure theory of gravitation. It is shewn upon most certain evidence that several of these require sensible correction. It is also shewn (apparently beyond doubt) that a term must be introduced into the moon's latitude, and possibly some terms into the moon's longitude, of a

form whose existence has hitherto been actually denied by theory. Every apparent contradiction which the theory of gravitation has hitherto received has served ultimately to confirm that theory; and it is probable that the terms to which we allude here, though discovered purely from observation, may yet be shewn to be a legitimate and necessary consequence of theory. The astronomical antiquarian and speculator on the construction of astronomical instruments may perhaps find some worthy food for reflection in the remarks made by the Astronomer Royal on the desertion of the correct principles of instrumental construction by the most celebrated instrument-makers of the last century, and on the uncertainty even of the most important geographical element in the position of the observatory as determined from the observations made at that time.

The Astronomer Royal has for some time past been occupied with the preparation of a catalogue of stars from all the observations made at the Royal Observatory, from the beginning of 1836 to the end of 1847. In this catalogue the places of the stars are exhibited for two epochs, namely for 1840 and 1845. The reason for this separation is, that the increasing attention to the proper motions of stars forbids us to include in one group all the observations extending over a period so long as twelve years; at the same time that the frequent absence of determination of one element in one catalogue, while it is supplied in the other, makes it desirable that the two catalogues should be placed in juxtaposition. This catalogue would long since have been placed before the Society, but that the Astronomer Royal has thought it very desirable to take this opportunity of giving facilities for the introduction of his new method of correcting the places of stars, described in a communication to this Society. It has been necessary for this purpose to compute ten constants for every star. It was also necessary to compute day-constants for a considerable time. The Superintendent of the *Nautical Almanac* having, at the request of the Astronomer Royal, most liberally computed and furnished to him the necessary preliminary numbers to the end of the year 1860, the day-numbers peculiar to this method have been computed and will be printed, for every day from the beginning of 1849 to the end of 1860. The whole of the work is now finished, and a large portion of it is in the printer's hands.

The observations at the Cambridge Observatory have been carried on with spirit, though the attention which university duties demand from Professor Challis is so much taken from those of its director. As senior resident member of the newly-established Board of Mathematical Studies, and a professor actually engaged in lecturing, Professor Challis has reason to fear that he will be obliged to abandon a part of what he has hitherto undertaken. The observations of the sun, moon, and other planets, were discontinued at the beginning of last year. The new planets have been observed, when practicable, on the meridian, and at other

times with the Northumberland Equatoreal. The volume of *Observations* for 1843 is published. Its Appendices contain so many of the observations made in search of the planet *Neptune* as are required to substantiate the special Report made to the Senate in December 1846, and also the Astronomer Royal's description of the Northumberland Equatoreal and Dome.

The ninth volume of the *Oxford Observations* will be published in a short time, and it is to be hoped that no unnecessary delay may take place in the publication of the catalogue of circumpolar stars on which Mr. Johnson has been so long engaged. Astronomy can scarcely receive a more valuable acquisition, and if more aid is required for the laborious reductions, we doubt not that it will be readily granted by the Radcliffe trustees.

The long-delayed heliometer has arrived safely at the Observatory; but many months must elapse before it can be mounted, as the building in which it is to stand is not yet commenced. The instrument is of the largest class; its divided object-glass is  $7\frac{1}{2}$  inches in diameter, and of 10 foot focal length. The mounting is equatoreal, on a plan of Repsold, the constructor. By some departures from the ordinary German method, the right ascension and declination circles are 3 feet in diameter. There are also many modifications, hereafter to be described, in the structure of the instrument in its strictly heliocentric capacity. From such an instrument, in Mr. Johnson's hands, the Council feel justified in expecting future announcements of the greatest interest and value.

The repairs of the Edinburgh Observatory have been completed in a very efficient and satisfactory manner by the Government, who have further carried out the terms of the transfer of the property, by appointing a Board of Visitors to make an annual report on the manner in which the business of the Observatory has been carried on during the last year.

The Board is composed of five official members, connected with the various educational and scientific establishments of Edinburgh, and nominated by the late Astronomical Institution, and five unofficial members appointed by the Government. Professor J. D. Forbes has been chosen President, and Professor the Rev. P. Kelland, Secretary. So officered, the new Board cannot fail to perform the duties intrusted to it in an efficient manner, to the advantage of science and to the satisfaction of the public.

The annual visitations are to be held in the month of April, in each year; but an extraordinary one took place last December, a few days after the constitution of the Board.

A printed Report, furnished by the Astronomer to the members on that occasion, describes the buildings as having been put into the excellent condition above described, and mentions that a number of small alterations and improvements had been effected

upon the transit instrument and mural circle ; and that observations were beginning again, at the same time that the old work is being brought up. The calculations of 1842 are completed and nearly printed, and those of 1843 commenced.

The distribution of the printed volumes to foreign observatories and societies is mentioned as a difficult and uncertain task ; but the services of the Assistant Secretary of the Royal Astronomical Society in expediting and facilitating the transit of such parcels, are thankfully acknowledged.

The Liverpool Observatory has frequently been mentioned in our *Notices*, and its progress described ; we have now the pleasure of announcing its complete equipment and full activity. As we may fairly expect numerous and valuable contributions from this Observatory, which may be proposed as a model for similar institutions, it is proper briefly to recall its history to mind.

The propriety of establishing an observatory to give true time at the great port of Liverpool was brought prominently forward when the British Association held its meeting there. The plan of the existing observatory, with its instruments, was furnished by the Astronomer Royal. The site was selected, or approved of, by Messrs. Baily, Smyth, Dollond, Dawes, and Lassell, and the director, Mr. Hartnup, was appointed on the recommendation of the Astronomical Society. We may, perhaps, be allowed to say, that the Liverpool Observatory Committee consulted judicious advisers ; the Town Council assuredly has been most liberal in carrying that advice into effect. Let us hope that our other sea-ports may be induced to follow the example of Liverpool, even at a humble distance.

The Observatory, besides a convenient house for the astronomer, contains a transit-room, equatoreal-room with a revolving dome, chronometer-room, and computing-room. The three first adjoin each other. The transit instrument has a telescope of 5-feet focus and 4 inches aperture. It is of the strongest form, made by Messrs. Troughton and Sinms, on the plan of the Astronomer Royal. The transit clock is by Molyneux, and so is the mean-time clock, which is in the chronometer-room. The two clocks are so placed that they are compared by coincident beats. The chronometer-room is fitted up for receiving the chronometers which are sent for trial or rating, and contains a stove, heated by gas, for testing the chronometers. So perfect is the arrangement of this stove, that Mr. Hartnup can maintain any required heat, for an unlimited time, within  $1^{\circ}$  or  $2^{\circ}$ . It is his habit to try all the chronometers sent to the Observatory in considerable variations of temperature, and to give the rates corresponding to the temperatures with every time-keeper when it is taken away. His experience seems to prove, that the well-known defect in the ordinary compensation is the cause of the largest errors which are now to be found in well-made chronometers, and that, so long as the oil continues good, the rate corresponds to the temperature. It seems probable, that the

chronometer errors in long voyages would be very greatly diminished by using the rates corresponding to the temperatures, and it is hoped that in time this practice may be introduced. It is, however, only at the Liverpool Observatory that such rates can be obtained.

Having these extraordinary facilities for experiment, Mr. Hartnup has contrived a balance to go uniformly at all temperatures, and the trials which he has made seem to shew complete success. These is no doubt as to the ingenuity of the construction, or as to its beneficial effect, so far as it goes. A chronometer on Mr. Hartnup's principle, constructed by Mr. Shepherd, is now on trial at Greenwich, where the value of the invention will be tested. It is, however, so little trouble to read a thermometer daily, and to bring up the chronometer error by the corresponding rate, that intelligent seamen must, before long, fall into the method. If, with such an institution as the Observatory, the shippers and captains of Liverpool go to sea with bad chronometers, wrong errors, or indifferent rates, they have no one to blame but themselves. The Corporation has done its duty.

The Liverpool instrument, which is most interesting to the present meeting is the magnificent equatoreal which has recently been added to the Observatory. This instrument is now mounted, and it appears to satisfy the expectations which were formed by those who had interested themselves in its erection. The object-glass by Merz (8 French inches in aperture and about 12 feet in focal length) is an exceedingly fine one. The polar axis is found to be very firm, and the hour-circle arrangement (in which an hour-circle is kept in motion by clock-work, and the instrument is clamped to it at pleasure, similar to that of the Northumberland equatoreal) is very convenient. But the part of it which exhibits the greatest novelty is the clock-work. The Astronomer Royal, who directed generally the mounting of this instrument, and whose tastes incline him to study the best constructions adopted by engineers, determined to adopt, for the regulation of the clock-work, the principle of the regulator known by engineers under the name of "Sieman's Chronometric Governor," a construction whose invention appears likely to form an era in the history of mechanical regulators. This construction can scarcely be adapted to the regulation of engines moved by weights, but it is applied without difficulty to engines driven by water-power or steam-power. The Astronomer Royal, therefore, adopted water-power for the moving force on the Liverpool clock-work (the water acting in the manner suggested by Messrs. Maudslays and Field, by a Barker's mill, receiving its supply at the bottom of its vertical axis). In the opinion of the Astronomer Royal this motive power is, in any case, superior to that of a weight. In many cases (as at Liverpool) it can be supplied in the ordinary commercial way; in other cases, the same body of water may be used over and over again, the winding up of the clock being effected by the operation of pumping the water back, a construction which requires no going-fusee.

For the Sieman's regulator, however, water (or something which may be cut off by degrees) is necessary; and one of the remarkable effects of that contrivance is, that there is consumed exactly as much of the water as (under the varying circumstances of friction and other mechanical resistance) may be necessary, and no more. For instance, if a heavier resistance be applied, the speed of the clock is not altered either theoretically or practically in the smallest degree, but the clock spontaneously adjusts the water-valve, so as to permit a greater flow of water exactly to the amount required to overcome that greater resistance. The application of this principle at Liverpool appears perfectly successful. In the application of it to similar instruments, it may be desirable to diminish the massiveness of some of the moving parts, in the construction of which the engineer has hardly remembered that he was regulating, not a steam-engine, but an astronomical instrument: the only injurious effect, however, of this massiveness is to make the instrument somewhat less sensitive to changes of force than it ought to be. In use the polar axis is so stiff, and suffers so little change of form, that the declination-circle can be used to measure moderate distances as safely out of the meridian as in it. As this circle is 4 feet in diameter, divided on the same engine as the Greenwich altitude and azimuth instrument, and read off by two microscopes, the accuracy of such differential measures approaches very nearly that of our best meridian instruments; and the stars of comparison can generally be selected from a standard catalogue. The observations of Petersen's second comet seem to justify very high expectations from the Liverpool equatoreal.

Mr. Hartnup has been urged to supply the place of Greenwich in observing the faint planets until the new meridian-circle is erected, and afterwards to observe them when they pass the meridian in daylight. This is, undoubtedly, one of the most difficult and laborious departments in practical astronomy, but it is most wanted. Mr. Hartnup would thus relieve Professor Challis, who is too much occupied to continue this class of observations much longer, and he would have the honour of completing a void in the observations of our National Observatory. Such a line may well satisfy the most ambitious observer.

A short account of the Liverpool Observatory has recently been drawn up by Mr. Hartnup for the information of the Observatory Committee, and has been printed by their direction.

As the transit and equatoreal retain their adjustments satisfactorily, the foundation of the Observatory is shewn to be sufficient.

The Council have awarded the Medal to Mr. Lassell of Liverpool, for his excellent construction of an observatory and its instruments, and the discoveries made with them. The President will, as usual, justify this award at the close of the meeting. Mr. Lassell is one of those men of business of whom this country can boast more than any other, who, in spite of the cares of superintending commercial or manufacturing enterprises, can

find time and energy to devote to the advancement of knowledge by their own outlay and personal efforts, and who can produce such results as are generally considered to be only attainable by help of the purse of a nation or a sovereign.

The Council have had, during the past year, to thank more than one of the Fellows for instructive lectures in aid of the interest of the ordinary meetings. To Sir John Lubbock, for his account of his planetary methods, and to the Astronomer Royal, for his account of the methods of Lord Rosse and Mr. Lassell in the construction of their reflecting telescopes, such thanks are most worthily due. The Astronomer Royal has presented to the Society the interesting models which illustrated his account, and the substance of his lecture will be published in the next number of the *Monthly Notices*. The Council always remember that the routine of the ordinary meetings involves details which are not attractive, but to which attention is necessary, and they are glad when an opportunity offers which, without diverting attention from the Society's sole object, the encouragement and promotion of astronomy, enables them to introduce variety into the usual proceedings.

We have had many occasions to express our obligations to Mr. Bishop, and to Mr. Hind, the Director of the South Villa Observatory, for the various services which they have rendered to astronomy, and particularly to this Society. We must here give our thanks to Mr. Bishop for the publication of his *Zodiacal Chart*, one Number of which, Hour I. to II., has already appeared. It is clearly engraved, on a bold scale, and contains all stars within  $3^{\circ}$  of the zodiac to the 10th magnitude, inclusive. In the explanatory memoir accompanying the chart, Mr. Bishop promises an early continuation. The Society will regret to hear that Mr. Hind is now suffering from his exposure to cold and over-zeal in computation; but it is hoped that his health may soon be re-established.

The progress made in restoring the Standard Yard, and in constructing verified and exact copies, has not gone on quite so successfully or rapidly as might have been expected. Some months ago, Mr. Sheepshanks reported to the Standard Committee that he had compared a brass bar with all those yards which were compared *originally* with the lost imperial standard, and which are not *known* to have suffered sensible change meanwhile. These gave a fair approximation to the length of the lost standard, quite as near as could be expected. There are several minor difficulties in getting a perfectly satisfactory value of the old yard, some of which may, perhaps, be partially got over by a second and more careful reduction of the original observations made by Messrs. Murphy, Baily, Donkin, &c. in 1834; but the truth is, that the length of the lost standard differed according to each observer, and probably would be estimated of a different length as viewed in reversed positions. The problem, therefore, is a somewhat indefinite one,

and in reality possesses very little interest; for the old standard is not *directly* connected with any exact linear measurement. The Astronomical Society's scale, on which so much good work was employed, clearly altered its state between 1834 and 1844, when it was remeasured by Mr. Baily, shortly before his death, and so cannot serve for this investigation.

The more interesting problem is that of *preserving* the new standard, and getting *facsimile copies* of it, when it is decided upon; and though most of the anticipated difficulties have been overcome, there are still some anomalies remaining, the cause of which is suspected but not yet thoroughly proved. The mode of making the comparisons between any two bars will be best understood by inspecting the apparatus. The process is very easy, and it seems certain that the effects of temperature are not to be feared. The perplexity which still remains is of the following nature. The comparisons in one set of observations agree very well, and, in general, the means of several sets taken at the same time; yet there may be a considerable discrepancy between these and the comparisons of another day. Some very recent observations seem to shew that this is, or may be, caused by an alteration in the light; but this is not very certain, nor is it very obvious how such a cause of error is to be eliminated without an *immense* number of observations. If, however, this stumbling-block can be removed, there seems no other obstacle to a satisfactory solution of the problem, though there is a good deal of disagreeable work to go through.

Mr. Sheepshanks has been necessarily compelled to pay a good deal of attention to the instrument for measuring heat—the mercurial thermometer, and he conceives that he is now able to correct the graduation almost as accurately as can be wished. Probably a communication on this subject may be laid before the Society, as the thermometer is an important astronomical instrument from its connexion with refraction. Though the measuring apparatus is not quite complete, it is so nearly so as to give a good idea of the kind of research now prosecuting in the cellars of the Society's apartments; and it will be shewn to any fellow who is interested in the subject. It is, indeed, very desirable that other persons should now take a share in the operations, which are of the simplest kind, but which require to be repeated by various eyes and hands before a precise judgment can be formed of their accuracy.

Within a very short time, copies have been received in this country of the "*Récherches sur la Parallaxe des Etoiles fixes*," par C. A. F. Peters," extracted from the *Memoirs of the Petersburg Academy*. This is the work to which (then in preparation for the press) allusion was made by M. Struve in his *Etudes*, and upon the conclusions of which M. Struve's numerical deductions for the distances of the fixed stars were founded. As a complete work, exhibiting and criticising every original investigation on the parallax of the stars that has been published up to the present time, and as

communicating the discussion, in the most elaborate form, of the observations made with modern instruments, probably the best in the world, this work must be regarded as one of very great value. The first part of it is devoted to an examination of what had been done up to the year 1842, beginning with Copernicus, Rothmann, and Tycho; reducing anew some observations of Flamsteed and Bradley, omitting none of the writers of the last and the present century, criticising boldly the instruments, the instrumental methods, the computations, and the results of Brinkley, Pond, and others, and then proceeding to the researches more peculiarly belonging to the writer's province. The stars personally examined by M. Peters are eight in number: *α Ursæ Minoris*, *α Aurigæ*, *ι Ursæ Majoris*, *Arcturus*, *α Lyræ*, *α Cygni*, 61 *Cygni*, *Groombridge 1830*. It would be extremely difficult, in a communication of moderate length, to give an idea of the amount and the variety of labour which the writer has employed to correct his results for every conceivable error, whether in the divisions of his circle (the great vertical circle by Ertel), the micrometer screws, the levels, &c., or in the coefficients of formulæ for refraction, temperature correction, aberration, nutation, or proper motion. Of *α Ursæ Minoris* about 280 observations are used; of each of the other stars, a number varying from 40 to 90. The largest parallax which he finds is that of *Groombridge 1830*, about  $\frac{3}{8}$  of a second. M. Peters then discusses the parallaxes of 35 stars, which had been treated by other observers; namely, 29 by M. Struve, and 6 by Bessel, Lindenau, &c. He treats these stars, not singly, but as a group, the proportion of their distances being assumed to be that given by the investigations of the *Etudes*; and thus, assuming a symbol to represent the average parallax of a star of the second magnitude, the parallax of every star may be expressed in terms of that symbol, and the whole of the results may be grouped together to form one grand equation with a single unknown quantity. It is thus that M. Peters arrives at the conclusion that the mean or average annual parallax of a star of the second magnitude is about  $\frac{1}{3}$  of a second. Probably no work that has appeared for several years past can be put in competition with this, as an instance of well-directed labour, based on the most delicate observations, and employed for one of the greatest objects of sidereal astronomy.

The political disturbances which have lately occurred throughout Europe have not been without effect upon astronomy. The Observatory of the Collegio Romano is closed, perhaps dismantled. But the apprehension of astronomers has been chiefly excited by the position of Professor Schumacher, who appears to be compromised by the Schleswig-Holstein dispute. No one would willingly suppose that the King of Denmark or the authorities of the Duchies would intentionally injure or disturb a man who has done so much honour to both. For nearly thirty years Professor Schumacher, by the *Astronomische Nachrichten*, by his immense correspondence, and by his numerous publications, has made Altona the centre of astronomical information, and given a cosmopolitan

character to the science. The liberality of former sovereigns has placed in his charge a magnificent collection of instruments, which, in his keeping, are really at the service of civilised Europe. He is Director of the Altona Observatory, to which we this year owe the discovery of two comets, all that have been discovered. If, indeed, we were to attempt to particularise the services which the Professor has rendered to astronomy, or even those which he has especially conferred on our own nation, we should have a very long list to set forth. His residence at Altona, adjoining the great mart of Hamburgh, in the great thoroughfare between Germany and the world west of it, has essentially contributed to his usefulness; in any other position, he could not effectually have executed his mission. What your Council apprehended was, that the propriety of leaving the Professor absolutely undisturbed, might not appear so obvious to the commissioners for effecting a reconciliation between the kingdom and the duchies, as it is to astronomers. Your Council, therefore, has taken the unusual step of requesting Lord Palmerston, if he can find a proper opportunity, to plead in the Professor's behalf. We all, as cultivators of astronomy, have lasting obligations to the Professor, and feel that any interruption of his avocations will be felt as a most grievous blow wherever an astronomer or an observatory is to be found. Let us hope that, as great pecuniary interests or questions touching national honour are not involved, the contending parties will acquiesce in the unanimous prayer of so many persons, and allow our excellent associate to finish his exemplary course in all honour and tranquillity.

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*Titles of Papers read before the Society between February 1848 and February 1849.*

1848.

- Mar. 10. Elements of *Neptune*. Mr. S. C. Walker.  
 Note on the Satellites of *Uranus*. M. O. Struve.  
 Elements of *Flora*. Mr. Graham.  
 Notice of Double Stars. Rev. W. R. Dawes.  
 Observations of *Flora*. Lieut. Maury.  
 Ephemeris of *Flora*. Mr. Hind.  
 Observations of Planets made at the Observatory, Durham. Professor Chevallier.  
 Ephemeris of *Flora*. M. Brunnnow.  
 Observations of newly discovered Planets. M. Rümker.  
 Observations of *Iris*. Mr. Cooper.  
 MS. Collection of Observations of Solar Spots. Rev. Dr. Hussey.  
 On Planetary Motions. Mr. Davison.  
 Observations of *Flora*. Sir Thomas Brisbane.

- Annular Eclipse of the Sun, Oct. 9, 1847. Major Lysaght.  
 On the Inner Satellites of *Uranus*. Rev. W. H. Dawes.  
 Observations of Mauvais' Comet. Professor Challis.  
 On the Level Errors of the Greenwich and Cambridge  
 Transits. Mr. Henry.  
 On Binocular Telescopes. Mr. Vallack.  
 Measures of Southern Double Stars, &c. Captain Jacob.  
 Observations of Moon and Moon-culminating Stars. Mr.  
 Dell.
- April 14. On a remarkable Appearance during the Lunar Eclipse,  
 March 19, 1848. Dr. Forster.  
 On a remarkable Appearance during the Lunar Eclipse,  
 March 19, 1848. Mr. Walkey.  
 Observations of Mauvais' Comet, &c. Mr. W. C. Bond.  
 On the Satellites of *Uranus*, &c. M. O. Struve.  
 On Engraving primary Information on Seamen's Watches.  
 Mr. Drach.  
 On a Parhelion seen near Oxford, March 29, 1848. Rev.  
 J. Slatter.  
 Observations of Mauvais' Comet. Mr. Lassell.  
 Observations of small Planets. Professor Challis.  
 Elements of *Flora*. Mr. Boreham.
- May 12. Observations of *Iris*. Dr. Kaiser.  
 Notice of Discovery of a New Planet. Mr. Graham.  
 Errors in Lalande and Groombridge's Catalogues. M. Faye.  
 Observations of small Planets, &c. M. Rümker.  
 Notice of Discovery of a New Star in *Ophiuchus*. Mr.  
 Hind.  
 Observations of Moon-culminating Stars. M. Jahn.  
 On the Longitude of Poona. Mr. H. Breen, jun.  
 Observations of Mr. Graham's Planet. M. Rümker.  
 Observations of *Metis* at Hartwell. Mr. Hind.  
 On a new Formula for reducing Observations of Circum-  
 polar Stars, &c. Captain Shortrede.  
 Double Stars measured at Poona. Captain Jacob.  
 On a regulated Time Ball. Professor Chevallier.  
 On a regulated Time Ball and Observations for finding  
 the Latitude by means of a Portable Transit Instru-  
 ment. Professor Chevallier.  
 Three Letters to Sir J. Herschel, respecting the New Star  
 in *Ophiuchus*. Mr. Hind.  
 Extract of Letter to Mr. Hind respecting the New Planet.  
 Mr. Graham.  
 On the New Star in *Ophiuchus*. M. Petersen.
- June 9. Observations of *Metis*. Professor Chevallier.  
 Observations of *Metis* and Hind's New Star. M.  
 Petersen.  
 Observations of *Metis*. Professor Chevallier.  
 Observations of *Flora*. Professor Chevallier.  
 First Elements of *Metis*. Mr. Graham.

- Ephemeris of *Metis*. Mr. Hind.  
 On a Method of approximating to the distance of a Planet from the Sun by means of two observations only, made near the Planet's Opposition. Professor Chevallier.  
 Eclipses of *Jupiter's* First Satellite, &c. observed at Charlotte Town, Prince Edward's Island. Captain Bayfield.  
 On the Lunar Eclipse of May 19, 1848. Rev. C. Mayne.  
 Corrections of the Elements of the Moon's Orbit, deduced from the Lunar Observations made at the Royal Observatory of Greenwich, from 1750 to 1830. The Astronomer Royal.  
 Notice of N. Kratzer, Horologier to Henry VIII. Colonel Batty.  
 Letter accompanying the Portrait of Captain Middleton, Founder of the Mathematical Society. Dr. Lee.  
 On the Planet *Neptune*. Messrs. Walker and Pierce.  
 On the State of the Edinburgh Observatory. Professor C. P. Smyth.  
 On the Latitude of Dera, and the Attraction of the Himalayas. Captain Shortrede.  
 On a Method of finding the Error and Rate of a Chronometer, from the observed Transits of Three Stars near the Meridian. Captain Shortrede.  
 On the Difference of Longitude between Paramatta and Port M'Quarrie. Captain Stanley.  
 On the figure of a Constellation on an ancient Punic Monument. M. Honegger.  
 On the Great Comet of 1843. Mr. Webb.  
 Nov. 10. Various Observations, &c. M. Rümker.  
 Notice of Ephemerides required shortly. Mr. Hind.  
 Encke's Comet with Ephemeris. Mr. Hind.  
 On *Iris* with an Ephemeris. Mr. Hind.  
 Elements of the Comet of 1847. Mr. Pogson.  
 Observations of *Flora* and *Metis*. Professor Challis.  
 Ephemeris of *Neptune*. Mr. Adams.  
 Ephemeris of *Metis*. Mr. Graham.  
 Observations of *Metis*. Mr. Graham.  
 Observations of *Flora*. Mr. Graham.  
 Notice of Errata. Mr. Woollgar.  
 Mean Places of Stars compared with Mauvais' Comet. Mr. Maclear.  
 Announcement of the Discovery of Petersen's Comet, Aug. 7, 1848, with Observations. Professor Schumacher.  
 On various Subjects, and Observations of Encke's Comet. Mr. Hind.  
 Observations of *Flora*. Messrs. Broun and Welsh.  
 Parallel between A. S. Catalogue and B. A. Catalogue. Mr. Woollgar.

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*Address delivered by the President (Sir J. F. W. Herschel, Bart.)  
on presenting the Honorary Medal of the Society to William  
Lassell, Esq., of Liverpool.*

GENTLEMEN,—The Report of the Council having been read, in which the astronomical discoveries of the year, and especially that of the planet *Metis*, have been clearly and eloquently commemorated, it is now my pleasing duty to state to you the grounds on which it has been agreed by us to award the gold medal of the Society for this year to Mr. Lassell. And this duty, pleasing in itself, I execute with the greater satisfaction, because I have a sort of hereditary fellow-feeling with Mr. Lassell, seeing that he belongs to that class of observers who have created their own instrumental means—who have felt their own wants, and supplied them in their own way. I believe that this greatly enhances the pleasure of observing, especially when accompanied by discovery, and gives a double interest in the observer's eyes, and perhaps, too, in some degree, an increased one in those of the public, to every accession to the stock of our knowledge which his instruments have been the means of revealing: upon the same principle that the fruit which a man grows in his own garden, cultivated with his own hands, is enjoyed with a far higher zest than what he purchases in the market. Nor is this feeling by any means a selfish one. It arises from the natural and healthy excitement of successful exertion, and is part of that happy system of compensation by which Providence sweetens effort, and honours well-directed labour. If this be true of the labour of a man's hands in the mere production of material and perishable objects, it is so in a far superior sense, when the faculties of the intellect are called into exercise, and works elaborated with rare skill, and wrought to an extraordinary pitch of perfection, have yet a higher, ulterior, intellectual object, to which their existence is subordinate, as means to an end.

Mr. Lassell has long been advantageously known to us as an ardent lover of astronomy, and as a diligent and exact observer, in which capacity he has appeared before us, as a reference to our *Memoirs* and *Notices* will testify, on numerous other occasions besides those to which I shall more particularly call your attention presently. In the year 1840 he erected an observatory at his residence near Liverpool, bearing the appropriate name of Starfield, which has ever since been the scene of his astronomical labours. Even at its first erection this observatory presented features of novelty and interest. In addition to a good transit it was furnished, instead of a meridian instrument or an ordinary equatorial achromatic, with a Newtonian reflecting telescope of 9 inches aperture, and rather more than 9 feet in focal length, equatorially mounted, the specula of which were of his own construction, and the mode

of mounting devised by himself. This was already a considerable step, and forms an epoch in the history of the astronomical use of the reflecting telescope. Those only who have had experience of the annoyance of having to keep an object long in view, especially under high magnifying powers, and in micrometrical measurements, with a reflector mounted in the usual manner, having merely an altitude and azimuth motion, can duly feel and appreciate the advantage thus gained. But the difficulties to be surmounted in the execution of such a mode of mounting were very considerable—much more so than in the case of an achromatic,—owing partly to the non-coincidence of the centre of gravity of the telescope and mirror with the middle of the length of the tube, and partly to the necessity of supporting the mirror itself within the tube in a uniform bearing free from lateral constraint, and guaranteed against flexure and disturbance of its adjustment by alteration of its bearings. These difficulties, however, Mr. Lassell overcame: the latter, which is the most formidable, by an ingenious adaptation of the balancing principle first devised, if I am not mistaken, by Fraunhofer and Reichenbach for the prevention of flexure in the tubes of telescopes—a principle which has not received half the applications of which it is susceptible, and which, by throwing the whole strain of the weight of instruments on axes which may be made of unlimited strength, may be employed to destroy the distorting force of gravity on every other part.\*

The success of this experiment was such, and the instrument was found to work so well, that Mr. Lassell conceived the bold idea of constructing a reflector of 2 feet in aperture and 20 feet in focal length, and mounting it upon the same principle. The circumstances of his local situation, in the centre of manufacturing industry and mechanical construction, were eminently favourable to the success of this undertaking; and in Mr. Nasmyth he was fortunate enough to find a mechanist capable of executing in the highest perfection all his conceptions, and prepared, by his own love of astronomy and practical acquaintance with astronomical observation and with the construction of specula, to give them their full effect. It was of course, however, the construction and polishing of the large reflector which constituted the chief difficulty of this enterprise. To ensure success, Mr. Lassell spared neither pains nor cost. As a preliminary step, he informs us that he visited the Earl of Rosse, at Birr Castle, and besides being favoured with more than one opportunity of satisfying himself of the excellent performance of that nobleman's 3-foot telescope, enjoyed the high privilege of examining the whole machinery for grinding and polishing the large speculum, and returned so well satisfied as to resolve on the immediate execution of his own ideas.

The mode of casting and grinding the mirror, differing in some

\* As, for example, the divided limbs of circles, and the spokes connecting them with their centres; an easy and simple mechanism, which, devised some time ago, and approved by the late M. Bessel, I may, perhaps, take some future opportunity to submit to the Society.—(*Note added in the Printing*).

of the details, though proceeding generally on the same principle as Lord Rosse's (*i. e.* by a chilled casting), has been described in a communication read to this Society on the 8th of December last. The polishing was performed on a machine almost precisely similar to that of his lordship. But finding after many months' trial that he could not succeed in obtaining a satisfactory figure, he was led to contrive a machine for imitating as closely as possible those evolutions of the hand by which he had been accustomed to produce perfect surfaces on smaller specula. This machine has been described (and a model of it, as well as Mr. Nasmyth's finished working drawings of it, exhibited) in the paper to which I have already referred, of which an abstract has been printed in our *Notices*, and must by this time be in the hands of every fellow here present, so that it cannot be necessary for me to recapitulate its contents. Suffice it to say that I have carefully examined both the drawings and the model, and having myself had some experience in the working and polishing of reflecting specula, approaching (though inferior) in magnitude to Mr. Lassell's, I am enabled to say that the machine seems to unite every requisite for obtaining a perfect command over the figure; and when executed with that finish which belongs to every work of Mr. Nasmyth, from the steam-hammer down to the most delicate product of engineering and mechanical skill, cannot fail to secure, by the oily smoothness and equability of its movements, the ultimate perfection of polish, and the most complete absence of local irregularities of surface. The only part which I do not quite like about it, or perhaps I should rather say which seems open to an *a priori* objection, refutable, and, in point of fact, refuted by the practical results of its operation, is the wooden polisher, owing to the possibility of warping should moisture penetrate the coating of pitch with which it is (I presume) enveloped on every side. Some unhygrometric, non-metallic substance, such as for instance earthenware, porcelain biscuit, or slate, would be free from this objection, though possibly open to others of more importance.

Both Mr. Lassell and Lord Rosse appear to be fully aware of the vital importance of supporting the metal, not only while in use, but also during the process of polishing, in a perfectly free and equable manner; but the former has adopted a mode of securing a free bearing on the supports, by suspending the mirror, which is a great and manifest improvement on the old practice of allowing it to rest on its lower edge, by which not only is the figure necessarily injured by direct pressure, but the metal is prevented from playing freely to and fro, and taking a fair bearing on its bed. As I have, however, on another occasion enlarged on the necessity of making provision against these evils, by a mechanism almost identical in principle, I need not dwell upon this point further than to recommend it to the particular attention of all who may engage in similar undertakings.

It is right that I should now say something of the performance of the 9-inch and 2-foot reflectors. And first, as regards the suc-

cess of the system of mounting adopted in securing the peculiar advantages of the equatorial movement. This appears to have been very complete. The measurements, both differential and micro-metrical, made with them, and recorded in our *Notices*, shew that in this respect they may be considered on a par with refractors, and in facility of setting and handling they appear no wise inferior. Of the optical power of the former instrument, two facts will enable the meeting to form a sufficient judgment. With this Mr. Lassell, independently and without previous knowledge of its existence, detected the sixth star of the trapezium of *Orionis*. And with this, under a magnifying power of 450, and in very unfavourable circumstances of altitude, both himself and Mr. Dawes became satisfied of the division of the exterior ring of *Saturn* into two distinct annuli, a perfectly clear and satisfactory view of the division being obtained.

The feats performed by the larger instrument have been much more remarkable and important. It has established the existence of at least one of the four satellites of *Uranus*, which since their announcement by Sir W. Herschel had been seen by no other observer, viz. the innermost of all the series, and afforded strong presumptive evidence of the reality of another, intermediate between the most conspicuous ones. The observations of M. Otto Struve, if they really refer to the same satellite, are of nearly a month later date.

To Mr. Lassell's observations with this telescope we also owe the discovery of a satellite of *Neptune*. The first occasion on which this body was seen was on the 10th of October, 1846, but owing to the then rapid approach of the planet to the end of its visibility for the season, it could not be satisfactorily followed, until the next year, when, on the 8th and 9th of July, observations decisive as to its reality as a satellite were made, and in August and September full confirmation was obtained. This important discovery has since been verified both in Russia and in America. I call it so, because, in fact, the mass of *Neptune* is a point of such moment, that it is difficult to overrate the value of any means of definitively settling it. Unfortunately, the exact measurement of the satellite's distance from the planet is of such extreme difficulty, that, up to the present time, astronomers are still considerably at issue as to the result.

I come now to the most remarkable of Mr. Lassell's discoveries, one of the most remarkable, indeed, as an insulated fact, which has occurred in modern astronomy; though, indeed, it can hardly be regarded as an insulated fact, when considered in all its relations. I need hardly say that I allude to the discovery of an eighth satellite of *Saturn*; a discovery the history of which is in the highest degree creditable, not only to the increased power of the instruments with which observatories are furnished in these latter days of astronomy, but also to the vigilance of observers. If I am right in the principle that discovery consists in the certain knowledge of a new fact or a new truth, a knowledge grounded on positive and tangible evidence, as distinct from bare *suspicion* or *surmise* that such a fact exists, or that such a proposition is true—if I am right in assigning as the moment of discovery, that moment when the disco-

verer is first enabled to say to himself, or to a bystander, "I am sure that such is the fact,—and I am sure of it, *for such and such reasons*," reasons subsequently acquiesced in as valid ones when the discovery comes to be known and acknowledged—if, I say, I am right in this principle (and I really can find no better), then I think the discovery of this satellite must be considered to date from the 19th of September last, and to have been made simultaneously, putting difference of longitude out of the question, on both sides of the Atlantic. In speaking thus, I desire, of course, to be understood as expressing only my own private opinion, and in no way as backing that opinion by the authority of the Society whose chair I for the moment occupy. The Astronomical Society receives with equal joy the intelligence of advances made in that science from whatever quarter emanating, and accords the meed of its approbation to diligence, devotion, and talent, with equal readiness wherever it finds them—but declines entering into *nice* questions of personal or national priority, and would, I am sure, emphatically disavow the assumption of any title to lay down authoritative rules for the guidance of men's judgments in such matters. The medal of this day is awarded to Mr. Lassell, not on account of this discovery alone, and as such, but as taken in conjunction with the many other striking proofs he has afforded of successful devotion to our science—both in the improvement and in the use of instruments. And among the motives which have induced your Council to place Professor Bond on the list of our Associates (I trust not long to be the only one of his countrymen by whom that honour is enjoyed), though this discovery has had its due and just weight, we have not been unheedful of his general merits, both as an observer and as a theoretical astronomer—merits of which the *Memoirs* which have recently reached us convey the most abundant evidence in both departments.

I have observed that, when taken in all its relations, the discovery of an eighth satellite of *Saturn* cannot be regarded as quite an insulated fact. Between *Iapetus* and *Titan* there existed a great gap unfilled, in which (as formerly between *Mars* and *Jupiter*) it was not in itself unlikely that some additional member of the Saturnian system might exist. The extreme minuteness of *Hyperion* forcibly recalls the analogous features of the asteroids, and it would be very far from surprising if a further application of the same instrumental powers should carry out this analogy in a plurality of such minute attendants.

Mr. Lassell, as you are all well aware, is bound to astronomy by no other tie than the enjoyment he receives in its pursuit. But in our estimation of his position as an Amateur Astronomer it must not be left out of consideration, that his worldly avocations are such as most men consider of an engrossing nature, and which entitle them in their moments of relaxation, as they conceive, to enjoyments of a very different kind from those which call into fresh and energetic exertion all their faculties, intellectual and corporeal. It is no slight and desultory exercise of those faculties which will enable any man to carry into effect so much thoughtful combination, and to avail himself with so much consecutiveness of their

results when produced. And however we may and must acknowledge that such a course of action is really calculated to confer a very high degree of enjoyment and happiness, we ought not to feel the less gratefully towards those who, by their personal example, press forward the advent of that higher phase of civilisation which some fancy they see not indistinctly dawning around them; a civilisation founded on the general and practical recognition of the superiority of the pleasures of mind over those of sense; a civilisation which may dispense with luxury and splendour, but not with the continual and rapid progress of knowledge in science and excellence in art.

I think I should hardly be doing full justice to my subject or to the grounds taken by the Council in the award, if I were to conclude what I have to say otherwise than in the pointed and emphatic words of a Report officially embodying the prominent features of the case. "The simple facts," says that document, "are, that Mr. Lassell cast his own mirror, polished it by machinery of his own contrivance, mounted it equatorially in his own fashion, and placed it in an observatory of his own engineering: that with this instrument he discovered the satellite of *Neptune*, the eighth satellite of *Saturn*, and re-observed the satellites of *Uranus*. A private man, of no large means, in a bad climate" (nothing, I understand, can be much worse), "and with little leisure, he has anticipated, or rivalled, by the work of his own hands, the contrivance of his own brain and the outlay of his own pocket, the magnificent refractors with which the Emperor of Russia and the citizens of Boston have endowed the observatories of Pulkowa and the Western Cambridge."

*(The President then, delivering the Medal to Mr. Lassell, addressed him in the following terms):—*

And now, Mr. Lassell, all that remains for me is to place the medal in your hands, and to congratulate you on your success and on the noble prospect of future discovery which lies before you, now that, free from the preliminary labour of construction, your whole attention can be devoted to using the powerful means you have created. In the examination of the nebulae, in the measurement of the closest double stars, and the discovery of others which have hitherto defied separation—in the physical examination of the planets and comets of our own system, there is a wide field open and the sure promise of an ample harvest; and I can only add, that we all heartily wish you health and long life to reap it.

The Rev. W. READ, M.A.,  
Summer Place, Broughton,  
Manchester;  
BENJAMIN BELL, Esq., Jes-  
mond Villas, Newcastle-on-  
Tyne;

THOMAS WEDDLE, Esq., Wim-  
bledon;  
ROBERT STEPHENSON, Esq.,  
M.P.; and  
THOMAS COVENTRY, Esq.,  
5 Old Sq., Lincoln's Inn,

were balloted for and duly elected Fellows of the Society.

The Meeting then proceeded to the election of the Council for the ensuing year, when the following Fellows were elected, viz. :

*President :*

G. B. AIRY, Esq. M.A. F.R.S. *Astronomer Royal.*

*Vice-Presidents :*

JOHN CROUCH ADAMS, Esq. M.A.

EDWARD RIDDLE, Esq.

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## ROYAL ASTRONOMICAL SOCIETY.

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VOL. IX.

\* *March 9, 1849.*

No. 5.

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G. B. AIRY, Esq., Astronomer Royal, President, in the Chair.

Mons. V. Fasel, of Stow, near Aylesbury;

Commander W. T. Bate, R.N., South Sea, Portsmouth;

Wm. Brooke, Esq., Gray Friars' Priory, Norwich;

Edward Bury, Esq., 14 Moorgate Street; and

Henry Barrow, Esq., 26 Oxendon Street;

were balloted for and duly elected Fellows of the Society.

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The annual 4to. half-volume, containing the more extensive memoirs, for the year 1847-48, is just completed, and will be ready for delivery in a few days. The price is 6s. to Fellows of the Society and 12s. to the Public. The annual 8vo. half-volume, which contains the observations, shorter memoirs, abstracts, &c. is *given* with the 4to. half-volume. The two are complementary to each other, and scarcely contain any thing in common, except the Annual Report.

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At the conclusion of the Annual Report, mention is made of an application by the Council to Viscount Palmerston, requesting his lordship's good offices in favour of our venerable and respected associate, Professor Schumacher. We are happy to say that his lordship not only received the application with the utmost courtesy, but has brought the matter before the Danish Government with great earnestness, and we trust with the best effect. It is understood that similar representations have been made by almost all the civilised states in Europe, a remarkable tribute to the individual merits of Professor Schumacher, and honourable to all the parties concerned. The occasion is new, and the unanimous and spontaneous expression of feeling in different countries is most creditable to the character of the science and to its cultivators.

We subjoin a letter addressed to the Royal Astronomical Society, by the President and Mathematical Section of the Imperial and Royal Institute of Sciences, Letters, and Arts, in the Venetian Provinces :—

\* For economical reasons, a portion of the abstracts is reserved for the next *Notice*.

*“ To the Royal Astronomical Society of London, from the Members of the Mathematical Section of the Imperial and Royal Institute of Sciences, Letters, and Arts, in the Venetian Provinces.*

“ Repeated communications from some of our members to the mathematical class of the Institute, have excited in us the painful apprehension that the recent disputes between the German Diet and the Kingdom of Denmark, with respect to the duchies of Schleswig-Holstein, may endanger the actual centre of astronomical relations, the celebrated establishment and observatory of Altona, by suspending the valuable labours of the Nestor of living astronomers, the meritorious and illustrious Councillor Schumacher,—an event which would be injurious in the highest degree to astronomical science and to all its ardent cultivators.

“ The Royal Astronomical Society of London, to which Astronomy and Navigation are so deeply indebted, can measure better than any other scientific body the irreparable loss which theoretical and practical Astronomy would suffer, should any material change be made in that admirable establishment. The Royal Astronomical Society well knows the indefatigable activity of Professor Schumacher, appreciates the felicity of his geographical position, in one of the greatest centres of communication between civilised nations, and estimates, at its due value, the extent and refinement of the plan of the *Astronomische Nachrichten*, in which for nearly thirty years the learned editor has published with the greatest promptness every discovery, and every new step towards perfecting Astronomy, Geography, and Mathematics.

“ The Observatory of Altona, owing to the intelligence and activity of its director and chief, and to its favourable situation, must be regarded as an European institution; and all those who are friendly to the progress of science should interest themselves in its preservation.

“ As the Government of England will, doubtless, have a large share in settling the disputes which do or may compromise the fortune of so important an establishment, we apply to your illustrious Society, in the confident hope that, in our name as well as in your own, you will interpose your good offices for the preservation of the actual state of the Observatory of Altona, and of its incomparable director.

“ This prayer of Science will doubtless find favour from the enlightened Government of your powerful and civilised nation,—a nation by which, in all time, Astronomy, Geography, and Navigation, have been vigorously protected and promoted.

“ LUDOVICO MENIN, President of the Institute, and Professor of History in the University of Padua.

“ SERAFINO RAFFAELLE MINICH, Professor.

“ CARLO CONTI, Professor of Mechanics.

“ DOMENICO TURAZZA, Professor of Geodesy and Hydrometry.

“ GIOVANNI SANTINI, Professor of Astronomy.

“ GIUSTO BELLAVITIS, Professor of Descriptive Geometry.”

## IRIS.

## Observations.

LIVERPOOL.			Equatoreal.			(Mr. Hartnup.)		
	Greenwich M.T.			R.A.	N.P.D.	Comp <sup>d</sup> —Observ <sup>d</sup> .		Star.
1849.	h	m	s	h	m	s	R.A.	N.P.D.
Jan. 22	13	18	59.5	10 18 13.80	87 47 43.8	...	...	<i>a</i>
30	12	0	57.0	11 40.00	33 19.9	+0.11	+2.6	<i>b</i>
31	10	54	21.7	10 47.72	30 45.3	+0.14	2.9	<i>b</i>
Feb. 8	10	47	36.1	10 3 0.88	87 3 26.9	-0.25	7.1	<i>c</i>
12	11	44	20.9	9 58 52.66	86 46 11.1	0.19	5.3	<i>d</i>
13	10	47	28.2	57 53.60	41 47.6	0.55	5.0	<i>d</i>
17	11	49	43.6	53 44.32	22 16.6	0.73	7.3	<i>e</i>
19	9	19	57.2	51 48.90	86 12 42.0	0.83	7.8	<i>e</i>
26	9	35	43.6	45 0.20	85 35 50.7	1.00	4.2	<i>f</i>
28	9	48	48.6	43 10.92	25 3.8	1.17	4.7	<i>f</i>
Mar. 1	9	54	31.0	42 18.02	19 41.6	1.45	4.0	<i>f</i>
2	10	40	25.3	41 24.45	14 9.7	1.14	4.8	<i>f</i>
3	11	29	22.0	40 32.44	85 8 41.3	1.31	2.7	<i>f</i>
5	11	12	27.4	9 38 55.94	84 58 9.7	-1.37	+4.1	<i>f</i>
<i>a</i>	3458, 3684			B.A.C.	<i>d</i>	3412, 3483 B.A.C.		
<i>b</i>	3483, 3570			—	<i>e</i>	3374, 3449 —		
<i>c</i>	3412, 3532			—	<i>f</i>	3295, 3412 —		

"The places of the stars of comparison are taken from the catalogue cited. The observed places are corrected for refraction and parallax. The computed places are deduced from the *corrected* ephemeris of MM. Pogson and Hind, which is printed in the present *Monthly Notice*.

"The N.P.D. are all from the circle readings. The method of observing is to select two stars from the B.A.C.; in general, one preceding and the other following the planet; one north and the other south of the planet. The instrument is firmly clamped in R.A., and the transits of the two stars and planet observed, each over five wires, the bisection with the horizontal wire is made at the time of transit by means of the slow motion screw attached to the declination circle. Immediately after each transit the two micrometer microscopes of the declination circle are read. The instrument is then unclamped in R.A., and the observations repeated, sometimes with the instrument in the same position as regards the declination circle; at other times the declination-axis is reversed for the second series, when the microscopes can be conveniently got at after so doing."

DURHAM. Fraunhofer Equatoreal. (Professor Chevallier and Rev. R. A. Thompson.)

	Greenwich M.T.			R.A.	N.P.D.	Comp <sup>d</sup> —Obs <sup>d</sup> .	No.	Star.
1849.	h	m	s	h	m	s	R.A. N.P.D.	Comp.
Feb. 7	12	27	34.7	10 3 56.69	87 7 8.5	+0.36	+6.6	4 <i>a</i>
8	9	57	14.6	10 3 2.95	87 3 36.3	-0.21	6.3	8 <i>a</i>
13	9	56	21.3	9 57 55.72	86 41 57.6	0.48	4.8	6 <i>b</i>
19	11	28	37.6	51 42.96	12 18.6	0.30	3.8	6 <i>c</i>
20	8	28	30.3	50 50.37	7 49.2	0.48	2.4	6 <i>c</i>
21	11	30	40.7	49 43.07	86 1 57.5	0.47	3.2	4 <i>c</i>
28	9	30	50.8	43 11.74	85 25 5.7	1.44	6.8	3 <i>d</i>
Mar. 3	9	3	42.0	9 40 37.04	85 9 8.4	-0.99	+7.8	6 <i>e</i>

The computed place is taken from the *corrected* ephemeris published in the present *Monthly Notice*.

The following are the assumed *apparent* places of the stars, deduced from one observation of each with the transit circle, except the last star, which has been brought up from the Edinburgh Observations for 1837.

		R.A.	N.P.D.
<i>a</i> = H.C. 19782	Feb. 7	10 1 38 <sup>h</sup> 03 <sup>m</sup>	86 53 38 <sup>s</sup> 4
<i>b</i> = H.C. 19722	13	9 58 20 <sup>h</sup> 90 <sup>m</sup>	86 50 29 <sup>s</sup> 1
<i>c</i> = B.A.C. 3412	19	9 51 54 <sup>h</sup> 21 <sup>m</sup>	85 53 59 <sup>s</sup> 8
<i>d</i> = H.C. 19268	28	9 41 50 <sup>h</sup> 61 <sup>m</sup>	85 12 23 <sup>s</sup> 6
<i>e</i> = B.A.C. 3359	Mar. 3	9 42 39 <sup>h</sup> 87 <sup>m</sup>	84 57 17 <sup>s</sup> 7

HAVERHILL.		Equatoreal.		(W. W. Boreham, Esq.)	
Greenwich M.T.		R.A.		N.P.D.	Obs. Star of Comp.
1849.	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	
Jan. 17	10 10 38	10 21 40 <sup>h</sup> 35 <sup>m</sup>	87 50 24 <sup>s</sup> 6	4	Weisse, x. 392
22	10 10 2	18 19 <sup>h</sup> 48 <sup>m</sup>	47 37 <sup>s</sup> 5	6	— 294
26	9 48 37	15 12 <sup>h</sup> 59 <sup>m</sup>	42 15 <sup>s</sup> 8	5	— 247
Feb. 2	10 51 14	8 55 <sup>h</sup> 23 <sup>m</sup>	25 1 <sup>s</sup> 6	1	— 107
8	10 1 14	3 3 <sup>h</sup> 34 <sup>m</sup>	87 3 26 <sup>s</sup> 9	4	— 6
10	9 52 9	1 3 <sup>h</sup> 75 <sup>m</sup>	86 55 33 <sup>s</sup> 9	4	— 6
11	9 45 59	10 0 0 <sup>h</sup> 79 <sup>m</sup>	51 5 <sup>s</sup> 5	6	— 6
12	10 1 44	9 58 56 <sup>h</sup> 72 <sup>m</sup>	46 11 <sup>s</sup> 9	5	H.C. 19722
13	10 2 57	57 55 <sup>h</sup> 56 <sup>m</sup>	41 38 <sup>s</sup> 3	5	—
15	10 39 41	55 50 <sup>h</sup> 39 <sup>m</sup>	32 43 <sup>s</sup> 1	10	B.A.C. 3436
16	10 2 4	54 50 <sup>h</sup> 26 <sup>m</sup>	27 55 <sup>s</sup> 6	5	—
17	10 47 26	53 47 <sup>h</sup> 19 <sup>m</sup>	22 44 <sup>s</sup> 6	6	Weisse, ix. 1149
19	10 4 9	51 46 <sup>h</sup> 97 <sup>m</sup>	12 53 <sup>s</sup> 9	8	B.A.C. 3412
20	10 44 12	9 50 45 <sup>h</sup> 18 <sup>m</sup>	86 7 30 <sup>s</sup> 5	5	—

Corrected for parallax and refraction.

HAMBURG.		Meridian Circle.		(M. C. Rümker.)	
Hamburg M.T.		R.A.		Dec.	
1849.	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>
Feb. 1	13 21 24 <sup>h</sup> 5 <sup>m</sup>	152 26 57 <sup>s</sup> 4	+ 2 32 13 <sup>s</sup> 7		
2	13 16 32 <sup>h</sup> 1 <sup>m</sup>	152 12 47 <sup>s</sup> 6	+ 2 35 16 <sup>s</sup> 9		

*Ephemeris of Iris* (by MM. Hind and Pogson) from Mr. Pogson's Elements, p. 42.

For Greenwich Mean Midnight.

1849.	App <sup>t</sup> R.A.	App <sup>t</sup> N.P.D.	1849.	App <sup>t</sup> R.A.	App <sup>t</sup> N.P.D.
<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>
Jan. 24	10 16 45 <sup>h</sup> 38 <sup>m</sup>	87 45 29 <sup>s</sup> 4	Jan. 30	10 11 40 <sup>h</sup> 15 <sup>m</sup>	87 33 22 <sup>s</sup> 6
25	15 57 <sup>h</sup> 60 <sup>m</sup>	43 56 <sup>s</sup> 2	31	10 45 <sup>h</sup> 34 <sup>m</sup>	30 42 <sup>s</sup> 7
26	15 8 <sup>h</sup> 51 <sup>m</sup>	42 12 <sup>s</sup> 3	Feb. 1	9 49 <sup>h</sup> 56 <sup>m</sup>	27 52 <sup>s</sup> 1
27	14 18 <sup>h</sup> 17 <sup>m</sup>	40 16 <sup>s</sup> 6	2	8 52 <sup>h</sup> 85 <sup>m</sup>	24 51 <sup>s</sup> 4
28	13 26 <sup>h</sup> 63 <sup>m</sup>	38 9 <sup>s</sup> 7	3	7 55 <sup>h</sup> 32 <sup>m</sup>	21 40 <sup>s</sup> 5
29	10 12 33 <sup>h</sup> 94 <sup>m</sup>	87 35 51 <sup>s</sup> 7	4	10 6 57 <sup>h</sup> 01 <sup>m</sup>	87 18 19 <sup>s</sup> 6

1849.		App <sup>t</sup> R.A.			App <sup>t</sup> N.P.D.			1849.		App <sup>t</sup> R.A.			App <sup>t</sup> N.P.D.		
		h	m	s	h	m	s			h	m	s	h	m	s
Feb.	5	10	5	58 <sup>00</sup>	87	14	48 <sup>07</sup>	Mar.	21	9	29	32 <sup>17</sup>	83	42	16 <sup>04</sup>
	6		4	58 <sup>39</sup>		11	8 <sup>07</sup>		22		29	11 <sup>11</sup>		38	16 <sup>09</sup>
	7		3	58 <sup>22</sup>		7	19 <sup>06</sup>		23		28	51 <sup>80</sup>		34	23 <sup>08</sup>
	8		2	57 <sup>56</sup>	87	3	21 <sup>09</sup>		24		28	34 <sup>22</sup>		30	37 <sup>05</sup>
	9		1	56 <sup>54</sup>	86	59	16 <sup>00</sup>		25		28	18 <sup>38</sup>		26	57 <sup>09</sup>
	10	10	0	55 <sup>18</sup>		55	2 <sup>05</sup>		26		28	4 <sup>26</sup>		23	25 <sup>01</sup>
	11	9	59	53 <sup>59</sup>		50	41 <sup>07</sup>		27		27	51 <sup>89</sup>		19	59 <sup>04</sup>
	12		58	51 <sup>81</sup>		46	13 <sup>05</sup>		28		27	41 <sup>25</sup>		16	40 <sup>07</sup>
	13		57	49 <sup>93</sup>		41	38 <sup>06</sup>		29		27	32 <sup>33</sup>		13	29 <sup>04</sup>
	14		56	48 <sup>02</sup>		36	57 <sup>05</sup>		30		27	25 <sup>12</sup>		10	25 <sup>02</sup>
	15		55	46 <sup>21</sup>		32	10 <sup>07</sup>		31		27	19 <sup>03</sup>		7	28 <sup>06</sup>
	16		54	44 <sup>56</sup>		27	18 <sup>08</sup>	April	1		27	15 <sup>81</sup>		4	39 <sup>02</sup>
	17		53	43 <sup>15</sup>		22	21 <sup>08</sup>		2		27	13 <sup>70</sup>	83	1	57 <sup>06</sup>
	18		52	42 <sup>05</sup>		17	20 <sup>04</sup>		3		27	13 <sup>26</sup>	82	59	23 <sup>02</sup>
	19		51	41 <sup>34</sup>		12	15 <sup>01</sup>		4		27	14 <sup>43</sup>		56	56 <sup>04</sup>
	20		50	41 <sup>08</sup>		7	6 <sup>00</sup>		5		27	17 <sup>24</sup>		54	37 <sup>02</sup>
	21		49	41 <sup>39</sup>	86	1	54 <sup>03</sup>		6		27	21 <sup>05</sup>		52	25 <sup>06</sup>
	22		48	42 <sup>29</sup>	85	56	39 <sup>08</sup>		7		27	27 <sup>07</sup>		50	21 <sup>05</sup>
	23		47	43 <sup>90</sup>		51	22 <sup>08</sup>		8		27	35 <sup>25</sup>		48	25 <sup>01</sup>
	24		46	46 <sup>29</sup>		46	3 <sup>09</sup>		9		27	44 <sup>39</sup>		46	36 <sup>05</sup>
	25		45	49 <sup>52</sup>		40	43 <sup>08</sup>		10		27	55 <sup>06</sup>		44	55 <sup>03</sup>
	26		44	53 <sup>65</sup>		35	22 <sup>07</sup>		11		28	7 <sup>26</sup>		43	21 <sup>08</sup>
	27		43	58 <sup>75</sup>		30	1 <sup>01</sup>		12		28	20 <sup>96</sup>		41	55 <sup>08</sup>
	28		43	4 <sup>88</sup>		24	39 <sup>02</sup>		13		28	36 <sup>14</sup>		40	37 <sup>05</sup>
Mar.	1		42	12 <sup>10</sup>		19	17 <sup>06</sup>		14		28	52 <sup>80</sup>		39	26 <sup>07</sup>
	2		41	20 <sup>49</sup>		13	56 <sup>08</sup>		15		29	10 <sup>89</sup>		38	23 <sup>06</sup>
	3		40	30 <sup>07</sup>		8	37 <sup>02</sup>		16		29	30 <sup>41</sup>		37	28 <sup>01</sup>
	4		39	40 <sup>90</sup>	85	3	19 <sup>03</sup>		17		29	51 <sup>34</sup>		36	40 <sup>01</sup>
	5		38	53 <sup>03</sup>	84	58	3 <sup>04</sup>		18		30	13 <sup>64</sup>		35	59 <sup>04</sup>
	6		38	6 <sup>51</sup>		52	49 <sup>06</sup>		19		30	37 <sup>31</sup>		35	26 <sup>03</sup>
	7		37	21 <sup>39</sup>		47	38 <sup>05</sup>		20		31	2 <sup>35</sup>		35	0 <sup>09</sup>
	8		36	37 <sup>70</sup>		42	30 <sup>03</sup>		21		31	28 <sup>72</sup>		34	43 <sup>01</sup>
	9		35	55 <sup>47</sup>		37	25 <sup>05</sup>		22		31	56 <sup>40</sup>		34	32 <sup>07</sup>
	10		35	14 <sup>75</sup>		32	24 <sup>03</sup>		23		32	25 <sup>38</sup>		34	29 <sup>07</sup>
	11		34	35 <sup>52</sup>		27	26 <sup>08</sup>		24		32	55 <sup>62</sup>		34	34 <sup>02</sup>
	12		33	57 <sup>85</sup>		22	33 <sup>04</sup>		25		33	27 <sup>11</sup>		34	46 <sup>02</sup>
	13		33	21 <sup>76</sup>		17	44 <sup>03</sup>		26		33	59 <sup>84</sup>		35	5 <sup>05</sup>
	14		32	47 <sup>26</sup>		12	59 <sup>08</sup>		27		34	33 <sup>78</sup>		35	32 <sup>00</sup>
	15		32	14 <sup>37</sup>		8	20 <sup>01</sup>		28		35	8 <sup>89</sup>		36	5 <sup>08</sup>
	16		31	43 <sup>13</sup>	84	3	45 <sup>06</sup>		29		35	45 <sup>11</sup>		36	46 <sup>06</sup>
	17		31	13 <sup>54</sup>	83	59	16 <sup>02</sup>		30		36	22 <sup>48</sup>		37	34 <sup>07</sup>
	18		30	45 <sup>63</sup>		54	52 <sup>02</sup>	May	1		37	0 <sup>98</sup>		38	29 <sup>09</sup>
	19		30	19 <sup>43</sup>		50	34 <sup>02</sup>		2		37	40 <sup>57</sup>		39	32 <sup>00</sup>
	20	9	29	54 <sup>94</sup>	83	46	22 <sup>02</sup>		3	9	38	21 <sup>23</sup>	82	40	41 <sup>02</sup>

\* A slight error was committed in the former ephemerides, which has been corrected in this. The interpolation is made from places calculated for every eight days, and is tolerably satisfactory.

Corrected for refraction, P is the horizontal parallax in arc, to be applied with the sign and coefficient to the observed places.

Feb. 22. Clock scarcely audible.

The following are the assumed *apparent* places of the stars of comparison deduced from observations with the transit circle, or as otherwise described:

		R.A. h m s	N.P.D. ° ' "	Obs.
Dec. 27	B.A.C. 1945	5 57 0.77	85 50 36.1	1
Jan. 16	$\alpha$ Orionis from the Nautical Almanac.			
17	H.C. 10991	5 40 21.09	82 30 30.6	1
26	B.A.C. 1826	5 38 35.87	80 32 29.0	2
30, 31	— 1851	5 41 44.59	80 10 48.9	1
Feb. 8	$\alpha$	5 36 16.43	78 39 53.6	
8	H.C. 10810	5 35 27.15	78 40 16.8	2
13	H.C. 10892	5 37 56.31	77 32 45.9	1
22	B.A.C. 1834	5 39 9.81	76 9 49.9	
26	H.C. 11092	5 43 48.25	75 52 28.3	2
28	B.A.C. 1853	5 42 13.13	75 36 26.9	

The place of  $\alpha$  depends on two comparisons with H.C. 10810, that of B.A.C. 1853 on four comparisons with B.A.C. 1852, which has been once observed. The place of B.A.C. 1834 depends on the Edinburgh Observations, 1837.

HAMBURG.	Meridian Circle.	(M. C. Rümker.)
1848.	Hamburg M.T. R.A.	N.P.D.
Jan. 23	9 25 4.5	81 18 0.6
27	9 8 13.3	80 36 33.1
Feb. 1	8 47 53.7	79 45 2.5

# FLORA.

HAMBURG.	Equatoreal.	(M. C. Rümker.)
1848.	Hamburg M.T. R.A.	N.P.D.
Dec. 24	17 14 36.1	207 11 12.7
28	17 0 19.0	208 28 56.0
29	17 45 7.5	208 48 48.8
1849.		
Jan. 2	17 35 10.2	210 3 40.7
3	16 55 51.0	210 21 17.4
31	16 50 2.1	217 34 52.5
Feb. 1	17 35 39.4	217 47 23.8
2	16 12 29.0	217 58 16.0

## NEPTUNE.

MARKREE.

In the Meridian.

(E. J. Cooper, Esq. and  
Mr. A. Graham.)

	Greenwich M.T.	R.A.	N.P.D.
1848.	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
July 28	14 22 51.3	22 16 30.64	101 25 34.0
Aug. 17	13 2 15.8	14 33.04	36 55.7
22	12 42 5.4	14 2.02	39 53.8
29	12 13 50.6	13 18.50	44 3.2
Sept. 22	10 37 8.8	10 58.10	101 57 9.5
29	10 9 2.4	10 22.89	102 0 24.0
Oct. 6	9 41 0.5	9 52.24	3 12.0
10	25 1.2	9 36.53	4 36.6
13	13 2.7	9 25.73	5 34.9
14	9 3.5	9 22.46	5 53.0
16	9 1 6.0	9 15.95	6 28.2
17	8 57 31.9	9 12.88	6 44.1
18	53 7.7	9 10.17	7 0.1
19	49 9.1	9 7.51	7 17.0
24	29 32.3	8 54.80	8 20.3
25	25 19.1	8 52.92	8 29.9
27	17 23.4	8 48.99	8 50.8
31	8 1 33.4	8 42.64	9 21.0
Nov. 1	7 57 36.2	8 41.36	9 27.5
2	53 39.2	8 40.24	9 34.4
3	49 42.3	8 39.21	9 38.3
7	33 55.8	8 36.39	9 49.5
9	26 3.3	8 35.93	9 51.4
15	7 2 29.1	8 36.98	9 40.9
20	6 42 54.4	8 41.94	9 10.5
22	35 5.1	8 44.53	8 53.5
24	6 27 16.8	8 48.07	8 32.5
Dec. 8	5 32 49.7	9 25.60	4 54.8
13	5 13 31.3	22 9 44.99	102 3 4.9

Oct. 17. The planet exceedingly faint; got but two wires; cannot depend on the bisection.

LIVERPOOL.

Equatoreal.

(Mr. Hartnup.)

	Greenwich M.T.	R.A.	N.P.D.	Star of Comp.
1849.	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>	
Jan. 17	6 36 43.7	22 13 15.95	101 43 15.3	7740, 7821 B.A.C.
26	5 58 15.9	22 14 25.94	101 36 43.8	— —

Corrected for refraction and parallax.

" The N.P.D. are from the readings of the circle.

" The places of the comparison stars are taken from the catalogue cited."

DURHAM. Equatoreal and Mer. Circle. (Prof. Chevallier and Rev. M. Thompson.)

	Greenwich M.T.			R.A.			Comp <sup>d</sup> —Obs <sup>d</sup> .	N.P.D.			Comp <sup>d</sup> —Obs <sup>d</sup> .	Obs.
1848.	h	m	s	h	m	s		°	'	"		
Sept. 18	10	25	47.0	22	11	19.61	+ 1.59					Mer.
	11	1	58.2			19.36	1.70	101	55	9.0	- 7.5	1
19	8	3	37.7	11	14	94	1.31	101	55	35.8	7.6	4
	10	21	45.5			14.08	1.65			40.6	9.5	Mer.
Oct. 9	9	1	34.0	9	40	38	1.55	102	4	14.3	7.5	—
24	8	1	50.0	8	54	93	1.65	8	20	8	11.5	—
25	7	57	51.9	8	52	72	1.75	8	28	9	8.5	—
Nov. 7	7	6	28.7	8	36	19	1.98	9	47	6	6.5	—
Dec. 4	5	20	54.5	9	12	27	1.78	6	10	9	9.1	—
5	6	30	15.9	9	15	53	1.80	102	5	50.2	7.5	6
22	6	46	25.1	10	27	27	2.18	101	58	59.9	7.6	6
28	5	50	33.6	11	0	90	1.55	55	52	5	6.5	4
1849.												
Jan. 15	6	13	48.3	13	1	00	1.42	44	40	1	8.3	2
17	6	14	2.9	22	13	15.12	+ 2.21	101	43	14.0	- 5.8	6

Corrected for parallax and refraction, and compared with Mr. Adams's *Ephemeris*.

The second observation on Sept. 18, and the first observation on Sept. 19, were made with the Fraunhofer Equatoreal, and the star of comparison was B.A.C. 7740. On Dec. 5th and the following days, *Neptune* was compared in like manner with B.A.C. 7821. The other observations were made in the meridian.

The positions of the stars have been assumed from the following mean places, for Jan. 1, 1848, as determined by meridian observations :—

	R.A.			N.P.D.			No. of Obs.
	h	m	s	°	'	"	
B.A.C. 7740	22	4	10.29	101	48	46.8	4
7821	22	18	36.84	101	59	54.0	5

LASSELL'S SATELLITE OF NEPTUNE.

LIVERPOOL.

(Mr. Lassell.)

Greenwich M.T.	Position.	Obs.	Distance.	Obs.
1848, Aug. 19.51	220°	eastd.	18.01	5
28.47	38.5	3		
Sept. 12.46	221.3	1		
18.47	223.8	4	16.21	4

CAMBRIDGE, U.S.

(Professor W. C. Bond.)

Cambridge M.T.	Position.	C <sup>d</sup> —O <sup>d</sup> .	Distance.	C <sup>d</sup> —O <sup>d</sup> .	Obs.
1847.	h	m	°	'	
Oct. 25	7	45	230	+ 0.3	15.4 — 0.3 3
27	7	30	29	+ 5.4	13.6 + 0.3 7
28	7	35	47	+ 3.2	14.9 — 0.4 9
30	7	0	218	- 3.7	15.6 - 1.4 3
Nov. 2	7	15	34	+ 1.8	14.0 + 0.8 5

*Eighth Satellite of Saturn (Hyperion).*

	Cambridge M.T.	Position.	C <sup>d</sup> —O <sup>d</sup> .	Distance.	O <sup>d</sup> —O <sup>d</sup> .	Obs.
1847.						
Nov. 3	7 0	51	+0.6	12.6	+1.1	4
26	7 26	45	-1.2	15.9	+0.2	15
1848.						
July 3	16 15	219	+4.1	16.2	+0.4	14
11	15 15	24	+3.5	12.0	-0.4	2
21	15 0	234	-5.8	16.2	-0.5	5
Aug. 31	10 30	225	-1.3	16.6	+0.2	14
Oct. 11	7 50	220	+0.6	16.4	-0.1	6
12	10 10	245	-2.2	9.6	-0.1	3
20	9 54	41	+3.3	15.8	+0.5	11
23	7 50	221	+2.6	16.3	+0.1	10
28	8 0	212	-3.7	11.2	+0.1	3
Nov. 1	7 0	221	-2.8	16.5	-0.7	4

The column headed C<sup>d</sup>—O<sup>d</sup> contains the differences between the Observed places and those Computed from the following orbit:—

Period 5<sup>d</sup>.8752

Inclination 30°

Ascending Node 300° if the motion is *direct*.

Passage of Ascending Node, Oct. 30.37, 1848, Greenwich M.T.

Mean Distance 16".3

The mass of *Neptune* corresponding to this distance is =  $\frac{1}{19400}$ .

EIGHTH SATELLITE OF SATURN (*Hyperion*).

CAMBRIDGE, U.S.      Equatoreal.      (Professor W. C. Bond.)

Camb. M.S.T.	Distance from Saturn's Centre.	Camb. M.S.T.	Distance from Saturn's Centre.
1848. Sept. 19.56	+256"	Oct. 21.42	-206"
21.52	+220	23.42	-178
22.44	+192	27.34	+88
23.38	+145	28.31	+136
28.38	-156	Nov. 1.31	+248
Oct. 13.32	+202	2.30	+198
14.29	+152	3.31	+228
15.40	+92	1849. Jan. 12.29	-132
20.31	-187		

In the above table + indicates that the Satellite *follows Saturn*; and — that it *precedes* the Planet.

The following is an approximation to the orbit of *Hyperion*, computed by G. P. Bond:—

Period ..... 21.18 days

Mean Dist. ... 214"

Eccentricity 0.115

Epoch ..... 97° Jan. 1, 1849

Perisaturnium 295°

The plane of the orbit coincides nearly with that of the ring. It probably undergoes very considerable perturbations from the influence of *Titan*.

## LIVERPOOL. 20-foot Reflector. (Mr. Lassell.)

1848.	Sept.	21 <sup>h</sup> 55 <sup>m</sup>	Hyperion	East of Saturn	234
		22 <sup>h</sup> 41 <sup>m</sup>	"	"	207
	Oct.	20 <sup>h</sup> 35 <sup>m</sup>	"	West	178
		22 <sup>h</sup> 44 <sup>m</sup>	"	"	203
	Nov.	14 <sup>h</sup> 36 <sup>m</sup>	"	"	133
		24 <sup>h</sup> 45 <sup>m</sup>	"	"	202.8

## SATELLITES OF URANUS.

## LIVERPOOL. (Mr. Lassell.)

		Satellite.	Position.	Obs. est.	Distance.	Obs.
1848.	Sept.	16 <sup>h</sup> 60 <sup>m</sup>	II.	200°		
			IV.	195		
			?	340	two diam. of planet.	
	18 <sup>h</sup> 53 <sup>m</sup>	II.	145° 4'	3	31'' 7	2
		IV.	158° 2'	2	45° 2	2
			?	305	est.	10
	Oct.	27 <sup>h</sup> 48 <sup>m</sup>	II.	332° 9'	4	31° 05
		IV.	178° 4'	4	41° 2	3
	Nov.	4 <sup>h</sup> 38 <sup>m</sup>	II.	351° 4'	3	30
		IV.	340	est.	44° 5	2
	30 <sup>h</sup> 46 <sup>m</sup>	II.	351	est.	32° 15	3
		IV.	353° 3'	2	43° 43	3
	Dec.	1 <sup>h</sup> 47 <sup>m</sup>	II.	324° 4'	2	25° 52
		IV.	336	2	40° 26	3

## ECLIPSES OF JUPITER'S SATELLITES.

## LIVERPOOL. Equatoreal. (Mr. Hartnup.)

			Imm.	Emer.		Power.
			<sup>h</sup> <sub>10</sub> <sup>m</sup> <sub>7</sub> <sup>s</sup> <sub>3.5</sub>	<sup>h</sup> <sub>11</sub> <sup>m</sup> <sub>49</sub> <sup>s</sup> <sub>30.4</sub>		
1849.	March	5	4th Satell.		Greenwich M.T.	271
		6	2d		—	180
				11 19 53.9		

" On March 5, while waiting for the emersion of the 4th satellite, I observed the contact and separation of the 2d and 3d satellites. One passed so nearly over the other, that at one time the elongation was only just perceptible.

	Greenwich M.T.	Greenwich M.T.	Power.
	<sup>h</sup> <sub>14</sub> <sup>m</sup> <sub>42</sub> <sup>s</sup> <sub>32.5</sub>	<sup>h</sup> <sub>14</sub> <sup>m</sup> <sub>52</sub> <sup>s</sup> <sub>40.9</sub>	
Contact		Separation	271

## ENCKE'S COMET.

CAMBRIDGE, U.S.

(Professor W. C. Bond.)

1848.	Cambridge M.T.			R.A. Jan. 1, 1848.			Decl. Jan. 1, 1848.			No. of Obs.	Star of Comp.
	h	m	s	h	m	s	°	'	"		
Aug. 27	14	1	44	3	19	28	+ 31	57	1	1	
29	12	50	53	23	31	2	32	36	29	13	a
30	12	57	36	25	46	2	32	57	47	11	b
31	12	40	1	27	58	9	33	19	3	10	c
Sept. 5	15	56	49	3	40	36	35	17	13	6	d
26	11	26	24	5	7	49	46	23	42	10	e
Oct. 8	16	35	57	7	26	35	53	3	36	6	f
27	17	30	39	12	19	51	25	5	29	8	g
Nov. 3	17	33	38	13	7	48	11	6	18	6	h
5	17	29	34	18	14	7	+ 7	43	58	6	i
13	17	56	8	13	53	52	- 3	34	57	10	k
20	18	17	33	14	25	18	11	38	55	4	l
25	18	5	20	14	52	59	- 16	44	49	4	m
Nov. 21	18	17	02	Comet precedes Mercury			7 <sup>m</sup>	29	35	by two compa.	
	18	5	36	— North of —			5'	44"	3	by one ,,	

"All the above positions have been determined with the *Micrometer* of the great equatoreal, with the exception of those on the 27th of August and the 25th of November, on which occasions the declination and hour-circles were used. The comet's places are corrected for refraction, but not for parallax. The places of the stars which follow are mostly from our own determinations.

## Mean Places of the Stars of Comparison, January 1, 1848.

Star	R.A.			Decl.			Mag.
	h	m	s	°	'	"	
a	3	23	40	+ 32	30	54	10
b	3	26	5	33	1	38	11
c	3	29	19	33	21	23	9
d	3	40	41	35	15	19	9
e	5	8	14	46	27	33	9
f	7	27	56	53	0	51	7
g	12	19	58	25	4	7	8
h	13	8	9	11	3	15	9 B. Z. 232
i	13	19	55	+ 7	42	4	9
k	13	53	48	- 3	34	45	8
l	14	28	55	11	39	20	7 B.A.C. 4828
m	14	42	28	- 15	24	24	3 — 4895

"August 27. The comet is faint and without concentration; its light is coarsely granulated, so that, were it not for its motion, it might be mistaken for a group of very small stars.

" September 26. A faint brush of light extends from the comet *towards* the sun.

" October 6. The comet is just visible to the naked eye. The brighter part is very eccentrically situated with reference to the general mass. A fan-shaped brush of light is very evident on the side *towards* the sun. There is no other appendage which can be called a tail.

" October 27. A faint ray of light is now seen directed from the sun.

" November 3. The comet shews a tail of one or two degrees, directed *from* the sun; with the same appearance on the opposite side as in October.

" November 5. The star of comparison is double, Dist. = 10"; that north preceding is used.

" November 21. The comparisons with *Mercury* have been corrected for refraction and for the planets' motion in the intervals of transit.

" November 25. At the first observation the altitude of the comet was 4°. The star was observed at nearly the same altitudes with the comet, so as to diminish the effect of errors in the refraction tables.

" The place given is probably accurate to within 0.5 in right ascension, and 5" or 10" in declination."

### PETERSEN'S SECOND COMET.

CAMBRIDGE, U. S.      Equatoreal.      (Professor W. C. Bond.)

1848.	R.A.			Decl.	No. of Obs.	Star.
	h	m	s			
Nov. 25	6	56	41	20 35 11.2	+ 37 24 15	2 <i>a</i>
27	6	58	34	20 43 45.8	34 52 24	6 <i>b</i>
28	6	55	53	20 47 58.3	33 34 54	3 <i>a</i>
29	6	55	16	20 52 10.5	32 16 4	1 <i>a</i>
30	8	20	36	20 56 35.6	30 51 18	3 <i>c</i>
Dec. 18	7	18	45	22 4 15.3	6 13 2	3 <i>d</i>
19	7	34	9	22 7 39.0	+ 4 54 25	4 <i>e</i>
1849.						
Jan. 22	6	42	22	23 42 13.2	-27 10 19	2 <i>f</i>

Corrected for Refraction and referred to the Mean Equinox, Jan. 1, 1848.

### Mean Places of Stars of Comparison for 1848.

	R.A.			Decl.	
	h	m	s		
<i>a</i>	20	40	3.75	+ 33 24 13.8	α Cygni
<i>b</i>	20	43	12.06	35 0 15.5	Lalande, 40277
<i>c</i>	20	59	22.45	30 57 32.7	B. Z. 306
<i>d</i>	22	4	19.51	6 8 58.3	Weisse, xxii, 78
<i>e</i>	22	6	25.42	+ 5 1 41.0	— —, 124
<i>f</i>	23	36	34.00	-27 5 15.9	Lalande, 46511

" The places on the 25th, 28th, and 29th of Nov. are from instrumental comparisons; the remainder are from micrometric differences, which were susceptible of great nicety, as the centre of the comet was indicated by a finely marked nucleus. On Nov. 30th, the nucleus passed within one second of arc of a star of the 12th mag., forming a close double star, but the contact was not complete. At the time of nearest approach the comet could be *seen to move*."

MARKREE.		Large Equatoreal.		(E. J. Cooper, Esq. and Mr. Graham.)		No. of Comp.
Greenwich M.T.		R.A.	Parall. Factor.	Decl.	Parall. Factor.	
1848.	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>		<sup>°</sup> <sup>'</sup> <sup>''</sup>		
Nov. 1	10 28 25.3	18 45 24.19	+ [9.824]	+ 59 46 48.1	+ [0.529]	10
2	8 58 8.0	49 45.53	9.777	59 10 46.0	0.251	8
3	7 54 38.4	18 54 12.53	9.691	58 32 54.1	9.927	10
7	7 43 48.1	19 12 47.86	9.635	55 41 5.0	0.016	10
14	7 54 33.1	19 45 17.39	9.585	49 40 58.0	0.280	10
20	8 43 53.1	20 12 41.88	9.599	43 27 34.5	0.513	5
22	7 7 33.7	20 21 17.60	9.498	41 15 21.6	0.396	5
29	7 47 31.5	* + 5.27	9.444	* - 14 22.5	0.592	10
Dec. 8	7 14 17.7	21 27 29.44	9.321	20 9 44.9	0.707	10
14	6 55 30.4	21 49 36.53	9.254	11 51 5.7	0.771	5
19	6 52 24.9	22 6 55.93	9.245	5 12 28.4	0.813	10
22	6 40 13.2	16 50.01	9.209	+ 1 25 25.7	0.833	5
23	7 41 1.3	* - 22.83	9.369	* - 2 55.7	0.840	5
27	6 30 14.7	22 32 34.31	+ [9.189]	- 4 28 18.2	+ [0.860]	5

The Parall. Factor is the log. of the number which, when divided by  $\Delta$ , gives the correction for parallax in seconds of time and of arc, for R.A. and Decl. respectively.

*Stars of Comparison and Notes.*

- Nov. 1. Piazzi, 18<sup>h</sup>: 220; 223.  
 2. B.A.C. 6463.  
 3. App. R.A. = 18<sup>h</sup> 52<sup>m</sup> 7<sup>s</sup>.88, Decl. = + 58° 33' 9".3, meridian circle.  
 7. App. R.A. = 19<sup>h</sup> 11<sup>m</sup> 17<sup>s</sup>.23, Decl. = + 55° 41' 2".9, ditto.  
 14. H.C. 37777.  
 20. — 38982, 6; 38990, 1; B.Z. 322: 20<sup>h</sup> 9<sup>m</sup> 25<sup>s</sup>.14; 29<sup>h</sup> 40.  
 High wind. The observation cannot be depended on.  
 22. H.C. 39393.  
 29. Rough place of star, R.A. = 20<sup>h</sup> 51<sup>m</sup> 29<sup>s</sup>, Decl. = + 32° 43'.  
 Dec. 8. B.Z. 196: 21<sup>h</sup> 36<sup>m</sup> 31<sup>s</sup>.00; 27<sup>m</sup> 33<sup>s</sup>.07; 28<sup>m</sup> 12<sup>s</sup>.00.  
 Blowing pretty hard.  
 14. H.C. 42762. Weisse xxi: 1155.  
 19. Weisse xxii: 124.  
 22. — — 380; 391.  
 23. Rough place of star, R.A. = 22<sup>h</sup> 20<sup>m</sup> 35<sup>s</sup>, Decl. = + 0° 11'.  
 27. H.C. 44337, 8, 9.

DURHAM. Fraunhofer Equatoreal. (Prof. Chevallier and  
Rev. R. A. Thompson.)

1848.	Greenwich M.T.	R.A.	N.P.D.	Obs.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	
Nov. 24	10 2 10.7	20 30 34.15	+ 049 P.	51 16 21.0 — 60 P. 5
30	10 33 11.6	20 56 9.14	0.044 P.	58 59 43.2 72 P. 3
Dec. 11	9 29 13.7	a + 1 21.97	0.039 P.	a + 5 22.3 74 P. 6
16	8 38 54.5	b - 2 8.60	0.035 P.	..... 1
	8 44 13.3	.....	b - 6 37.8	77 P. 1
28	7 19 22.3	22 35 41.26	+ 028 P.	95 37 31.8 — 85 P. 4

P is the horizontal parallax expressed in arc.

*Stars of Comparison.*

				R.A.			N.P.D.		
				h	m	s	°	'	"
Nov. 24	B.A.C.	7167	Dec. 11	21	37	43	74	5	
30	H.C.	40654	16	21	59	5	81	4	
Dec. 28	H.C.	44612							

"The places of the catalogued stars are taken from the authority cited. The first and last observations were made with the wire micrometer and red illumination; the others with the bar micrometer, without illumination.

"On Nov. 24, 11<sup>h</sup> 2<sup>m</sup> 30<sup>s</sup>, Greenwich M.T., the nucleus was close upon a fixed star, the place of which by two comparisons with B.A.C. 7167 was found to be—

R.A.			N.P.D.		
h	m	s	°	'	"
20	30	46.83	51	19	41.9

"The star was seen as before, but the comet appeared much fainter when near it."

*Elliptic Elements of Petersen's Second Comet.* By T. H. Safford.

Per. Passage,	Jan.	19 <sup>d</sup> 35269	1849, Greenwich M. T.
Long. Per. ....		63° 14' 31"	
Node.....		215 13 1	
Inclin. ....		85 3 3	
Log. Per. Dist. ....		9.9821429	
Log. Eccentricity ....		9.9999210	
Log. Mean Dist.....		3.7219822	
Period .....		382801 years.	

From observations, Oct. 25th, Dec. 18th, 1848; and Jan. 22d, 1849.

Professor Schumacher writes,—“I have received from Dr. D'Arrest, now assistant at the Leipzig Observatory, his third elements of Dr. Petersen's Second Comet, they are corrected after his observations made on Jan. 8, 9, 12, viz. :—

	Leipzig M.T.	R.A.	Dec.
	h m s	° ' "	° ' "
Jan. 8	4 57 59	346 39 44.6	—16 23 48.4
9	5 38 43	347 19 3.7	17 14 51.5
12	6 11 56	349 16 42.8	—19 45 44.5

"The elements of Dr. Petersen give the differences :—

	In R.A.	In Decl.
Jan. 8	—0.3	+ 52.6
9	—4.8	+ 39.2
12	+ 5.8	+ 56.1

"The second elements of Dr. D'Arrest,—

Jan. 8	+ 17.1	+ 6.7
9	+ 10.6	—11.0
12	+ 22.0	— 4.6

"His third elements, which he considers as very accurate, are the following. There seems to him not the least indication of ellipticity yet given by the observations.

Time of Perihelion Passage, 1849, Jan. 19, 39001, Berlin M.T.

$$\left. \begin{array}{rcl} \pi & 63 & 14 & 38.0 \\ \Omega & 215 & 12 & 50.4 \\ i & 85 & 2 & 50.6 \end{array} \right\} \text{Mean Eq}^{\circ}. 1849.0$$

Log.  $q$  9.9821197  
Motion Direct.

*Substance of the Lecture delivered by the Astronomer Royal on the large Reflecting Telescopes of the Earl of Rosse and Mr. Lassell, at the last November Meeting.\**

The Astronomer Royal gave that evening an account of the large reflecting telescopes of the Earl of Rosse and Mr. Lassell, which he had personally examined in the course of the last summer.

Premising that the subject might be considered interesting to the Society on these two grounds, first, that the reflecting telescope is exclusively a British instrument in its invention and improvement, and almost exclusively so in its use; and, secondly, that it had been almost exclusively the instrument of amateurs—a circumstance which seemed to prove both the difficulty of constructing it and its great excellence when properly constructed,—the Astronomer Royal remarked that his account would consist in some measure of a statement of the differences between the processes of these two amateur constructors. These differences, he thought, would be found well worthy the attention of all who were engaged in or contemplated the construction of reflecting telescopes. It is certain that both systems of methods are successful; and it may be doubtful how far the differences are connected with the difference of dimensions of the telescopes: for in all that follows it must be borne in mind that Lord Rosse's largest telescopes are 6 feet in clear aperture and more than 50 feet in focal length, while Mr. Lassell's are 2 feet in clear aperture and about 20 feet in focal length; that the thicknesses of the specula are nearly in the same proportion as their diameters; and hence that the weights of the specula are nearly as 27 to 1 (that of Lord Rosse's being about four tons, and that of Mr. Lassell's being about three hundred-weight), a difference which in itself might be expected to require some difference of construction.

I. The first difference is in the constitution of the metal-mixture used for the speculum.

In Lord Rosse's specula the metal is purely a mixture of tin

\* The Astronomer Royal has been kind enough to furnish this account at the urgent request of the Editor, though with great inconvenience to himself. The polishing apparatus of Lord Rosse is described in his paper, *Phil. Trans.* 1840, p. 515, and figured in plate xxi. The polishing apparatus of Mr. Lassell is figured in his memoir, which is ordered for publication. Fellows can see models of both, and of Lord Rosse's gigantic reflector, at the apartments of the Society.

and copper, in a proportion understood to be an atomic proportion, the weight of the copper being something more than double that of the tin. In the process itself there appears to be strong evidence that this proportion is truly atomic. When the metals are mixed in the intended proportions, it is found that the addition of one or two ounces of either metal to a mass of forty pounds of the mixture produces a difference so striking, that it is at once recognised by every person who is employed on the works. The mixed metal, when in fusion, possesses a remarkable union of penetrating power and of viscosity. It is so penetrating that Lord Rosse found it impossible to retain it in the ordinary cast-iron crucibles, which are cast with the mouth downwards; and he was compelled to have crucibles made expressly for this purpose, cast with the mouth upwards. It is at the same time so viscous, that when, in the casting of the speculum, the liquid metal is poured upon what Lord Rosse calls a "bed of hoops," that is, a broad base of the mould, formed by pressing together the flat surfaces of a great number of iron hoops, whose edges (trimmed into shape by turning and other mechanical operations) form the base, and through the interstices of which the air can escape; the metal itself does not in the smallest degree enter into these interstices. As soon as the cooling metal has acquired some consistency, it is dragged into the annealing furnace, every part of which has been brought to a low red heat. Great attention is given to the form of the floor of this furnace, as the metal is still in such a state that it receives figure from the furnace-floor. The furnace is then closed (care being taken to prevent one part from cooling, by radiation or convection, more rapidly than another), and after some weeks it is opened and the metal is taken out.

In Mr. Lassell's specula, the metal is made by first mixing copper and tin in the same proportions as those employed by Lord Rosse, and then adding a small quantity of white arsenic. It is well known that very great importance was attached to the admixture of arsenic by the principal constructors of reflecting telescopes in the last century. Lord Rosse has uniformly stated it as the result of his experience that, when the copper and tin are properly proportioned, nothing is gained by adding arsenic; Mr. Lassell is equally confident that the brightness of the metal is much improved by it. It would be idle to express an opinion on this point without comparing specimens of the two kinds of speculum-metal, side by side; and the Astronomer Royal only undertook to say that both bear a very high polish. The Astronomer Royal believed that the operation of annealing Mr. Lassell's mirrors was nearly similar to that for Lord Rosse's, although the trouble and risk of the process are of course materially diminished by the much smaller dimensions of the speculum.

The next step in Lord Rosse's operations is to turn (by a grinding process, with emery as the abrading powder) the edge of the mirror, the mirror being placed with its broad surface horizontal, with its lower surface and about one-third of its depth immersed in

water, and being turned horizontally by a vertical spindle passing through a stuffing-box in the bottom of the water-vessel. The purpose of this turning is, to make a nearly air-tight fitting for a covering which is to be applied to the mirror when it is not in use, and with which is connected a box of quicklime, for the desiccation of the air in contact with the mirror; and the object of turning it in water is, to keep all parts of the speculum in the same temperature, a caution which is necessary in every part of the operations. This caution is probably requisite only for specula as large as those of Lord Rosse. For these it was found by Lord Rosse that if the iron grinder (to be mentioned presently) be washed with warm water, and be then applied to the speculum, the metal almost infallibly cracks. A surface of warm pitch may, however, be applied without producing the same bad effect.

II. The subject next worthy of attention, rather for the similarity of the methods of the two constructors than for their dissimilarity, is the method of mounting the mirrors. And this seems to be a proper place for mentioning the mounting, because it is indispensable (at least with Lord Rosse's specula) that the mirror be ground and polished on the very same supports, applied in the very same manner, as when the mirror is in use in the telescope.

The special object of Lord Rosse's support is this: supposing the surface of the speculum to be divided into any number of equal portions, each of a form not particularly elongated in any direction, then the supports are to be so arranged that every one of these portions shall necessarily sustain the same upward pressure, acting at its centre of gravity. At the same time it is necessary, for definiteness of support, that the ultimate support upon the fixed frame be upon three points. These objects are thus attained; the surface of the mirror is divided into twenty-seven equal portions, and these are grouped into nine groups, of three in each; to each portion is attached, by felt and pitch, a small plate of cast iron; and in a small hole sunk in this cast iron, opposite to the centre of gravity, a projecting pin of a triangular plane lever takes its bearing. This triangular plane lever is merely a triangle, having three points to sustain pressure, and a small hole for the fulcrum at the centre of gravity of the three points considered as equal weights; it is, then, evident that if that point is made really the fulcrum, the pressures at those three points are necessarily equal. The same construction being applied to each of the nine groups, then it is only necessary to support the nine fulcra in such a way that the pressures upon them are necessarily equal; and this is done by grouping three of their fulcra as points of pressure upon the three points of another and stronger triangle, whose fulcrum is at the centre of gravity of these three points considered as equal weights; and this fulcrum is one of the points of the fixed frame. It will thus be evident that every one of the first-mentioned pins sustains exactly one twenty-seventh part of the whole weight of the mirror, or rather of the whole pressure of the mirror perpendicular to its surface, neither less nor more. (When the mirror is in the telescope,

it exerts also an edgewise pressure, which in Lord Rosse's construction was at first sustained by fixed pillars of the fixed frame; of these more will be said hereafter.) The fixed frame has small wheels; while it is in the grinding trough, it is so lifted off the wheels that it takes a firm bearing upon the rotating-frame; when it is to be carried to the telescope it is lowered to take bearing upon its wheels, the side of the grinding-trough is taken off, the fixed frame carrying the speculum is wheeled upon a proper carriage, the carriage conveys it to a place very near the telescope, where is a railway at proper height for receiving the small wheels; the telescope is placed vertical, its lower end is opened, and continuation-rails are laid to it, and the fixed frame is thus wheeled into the telescope, carrying the mirror; then by powerful screws the bearing of the fixed frame is received upon three points, the wheels being entirely lifted off their bearings. (Since giving this account, the Astronomer Royal has learnt from Lord Rosse that a speculum which was raised for a few minutes only from its lever-bearings received in that time a permanent change of figure.)

In Mr. Lassell's operations the speculum is supported on eighteen points, the grouping being first made by two and two, with straight levers, and then the fulcra of the straight levers being by means of triangular levers supported upon three ultimate points. The Astronomer Royal was not able to say whether the same cautions, as to retaining the speculum at all times upon the same bearings, which Lord Rosse found necessary, were required for Mr. Lassell's mirrors; but it is evident that the difficulties of support of every kind are here very much less. The edgewise pressure, when in the telescope, is here supported by a semicircular iron hoop, of which more will be said hereafter.

III. The next point deserving special comparison is the apparatus for grinding and polishing.

The apparatus used by Lord Rosse imitates very closely, but with that superior degree of regularity which is given by machinery, the operation of polishing by hand. Proceeding from the quick motions to the slow ones, the order of movements is as follows:— (1.) By a steam-engine, a rotatory motion round a vertical spindle is given to a crank, which by a connecting rod acts upon a sliding rod that moves the grinder or polisher backwards and forwards. This sliding rod passes through a fixed guide at the end next the connecting rod, and through a slowly moving guide [described under (2)], at the other end; and thus every stroke of the grinder is very nearly a straight stroke. The sliding rod is interrupted in its middle, and there its place is supplied by a hoop which loosely surrounds the grinder: this construction is necessary, because, on account of the great size and weight of the grinder, it is necessary that it be supported by counterpoises in various parts, at the same time that it is necessary that (in order to prevent the formation of striæ in a definite direction on the grinder) the grinder be left free to revolve: that motion of revolution is given merely by the friction

upon the mirror, whose rotation will be mentioned under (3); and depends upon the weight with which the grinder presses the mirror. (2.) A band from the crank-spindle (1) passes round a wheel which carries a crank, in which is the forked guide (turning by a spindle in the crank end), that guides the distant end of the sliding rod; and thus the strokes of the grinder do not pass uniformly over the centre of the mirror, but pass in their direction a certain distance to the right and left. But as, in the ordinary crank motion, the duration of the strokes at the extreme right and left would be too great, the wheel on the spindle of this grinding-crank is elliptical, the proportion of its axes being about three to one: its angular motion is, therefore, unequal; and the strokes are thus made to dwell a shorter time near the extreme right and left, and a longer time near the centre. (3.) Another band from the crank-spindle (1) passes round a large wheel on the vertical axis, that passes through a stuffing-box in the bottom of the grinding-trough, and there carries a broad frame, on which is placed the fixed frame of the mirror, supporting the mirror itself. Thus the mirror turns slowly round to receive the strokes of the grinder in every direction. It is only necessary to add to this, that a large part of the grinder's weight is equally supported at twelve points, by a lever counterpoise above it, which supports the centre of a triangle, each point of which (by a roller over which a cord passes) supports two points, each of which points is the middle of a straight lever whose ends are attached to the grinder.

In Mr. Lassell's apparatus (omitting some details, which are not now necessary, as a detailed account of this apparatus has lately been given by Mr. Lassell himself to the Society), the steam-engine puts in motion (1) a vertical spindle below, which turns the mirror slowly, and (2) a vertical spindle above, which has a horizontal arm, in which is a planet-wheel turned by its tooth-connexion with a fixed sun-wheel. The axis of this planet-wheel carries another wheel that works in a third wheel, whose spindle is carried by the horizontal arm, but whose place can be fixed at pleasure near to or far from the centre of the vertical spindle (2). An arm from the spindle of the third wheel carries a spike pointing downwards (the distance of this spike from the centre of the spindle of the third wheel being adjustable), and this spike lodges loosely in the centre of the grinder and moves it upon the face of the mirror. Thus it will be seen that the centre of the grinder is always moved in an epitrochoid (including the circle as a possible case, if the adjustment is made for that curve), in which the proportion of velocities of the two circles is fixed, but the radii and their proportions are adjustable. The grinder, as in Lord Rosse's construction, is allowed to take freely the rotatory motion which it may receive from the friction on the mirror; but no counterpoise is used, the weight of the grinder being comparatively small.

The essential difference of these constructions, as regards the movements of the grinder, is, therefore, this: that in Lord Rosse's

apparatus every stroke is very nearly straight, while in Mr. Lassell's apparatus there is no resemblance to a straight movement at any part of the stroke.

IV. The process of grinding is nearly the same (with differences corresponding to the difference of dimensions) in the operations of both constructors.

In Lord Rosse's grinding, the speculum having received an approximate figure from the form of the annealing furnace, the cast-iron grinder is brought very exactly to form by turning upon the lathe, with proper reference to a gauge, and (if not done before) its surface is scored with cross-furrows about two inches apart and nearly an inch deep, leaving the acting part of the surface in squares. The grinder is then mounted in the apparatus; and this is the most dangerous part of the whole operation. The slightest jar of the iron grinder upon the mirror would break the mirror; and to avoid this risk, a great number of thin wooden wedges is placed upon the edge of the mirror, the grinder is slowly lowered upon them, and then by degrees they are gently withdrawn. The grinder is then used to grind the surface, with the intermediate powder of emery and water; coarser and finer emery in succession. A heavy weight is allowed to press the grinder upon the mirror; and as the grinder itself suffers much in form, it is repeatedly re-turned upon the lathe. This operation sometimes lasts many days.

Of the grinder used by Mr. Lassell, the Astronomer Royal could give no account, but believes that it is of wood, the same which is used for polishing. The abrading powder used is the same as Lord Rosse's (emery, coarser and finer in succession).

V. The next point deserving attention is the important process of polishing.

When the figure of the speculum given by grinding is supposed by Lord Rosse to be sufficiently accurate, the projecting squares of the cast-iron grinder are covered with a coating of resin and turpentine, of such a consistence that, at a temperature of about 50° Fahrenheit, the nail can easily make an indentation in it. This is then covered with another coating, of a substance formed by combining the mixture last-mentioned with a certain quantity of wheat-flour, and of such a consistence that, at a temperature of 80° Fahrenheit, the nail can make an indentation in it. It is not to be understood that there is any particular virtue in the temperatures 50° and 80°, but (for reasons to be hereafter given) it is necessary to have two strata of different degrees of hardness (the harder being the exterior), and the hardnesses defined by those two temperatures having been used in many experiments, the other adjustments have been determined, using these as bases; and if these bases were now changed, every other adjustment must be changed.

The necessity for the different strata of resin is thus explained. It is necessary that the polisher yield a little, else the polishing surface could not be in contact with the mirror at all parts of its stroke (the mirror being supposed parabolical), and this yielding is given by the first or soft stratum. But it is also necessary that the

stratum next to the metal be hard; for if, in passing across a scratch or furrow, it were able to accommodate its form to that of the furrow, it would round off and polish the edges of the furrow, and this would very much injure the image of a bright object.

The coating is heated to softness by the flame of a torch, and the grinder is then lowered upon the mirror, and the coating takes the proper form. The mirror is exposed to no danger of cracking from this application.

The powder used is the red oxide of iron, prepared by precipitating (by means of ammonia) the black oxide of iron from a solution of sulphate of iron, and then heating the black oxide in a furnace with access of air. Lord Rosse finds that no other method of preparing the red oxide is successful. No polishing-patty or other powder of any kind is employed.

The powder is moistened with water to a degree known by experience, and then, the counterpoise of the grinder being so much increased that the remaining friction is enough to turn the grinder only once for about sixteen revolutions of the mirror, the operation goes on for about eight hours. It is essential, for reasons similar to those lately mentioned, that the temperature of the air and the temperature of the dewpoint have nearly certain definite values (the latter, that the water mixed with the powder may dry in the proper degree): if the external air is too dry, the air of the room is moistened by a jet of steam; if it is too damp, the polishing is not attempted.

After about eight hours, the grinder is lifted and a fresh application is made of powder mixed with "ammonia soap," a substance formed by treating common soap with ammonia. The metal then dries more rapidly, and the labour to the engine becomes much greater: the work is continued till the surface is dry, or very nearly dry; the grinder is taken off, and the mirror is found finished, having a parabolic figure, and a very high polish.

It is to be remarked here that the smaller mirrors made by Lord Rosse (3 feet diameter, about 25 feet focal length) were tried before they were used, by means of an object fixed something more than 50 feet above them, whose image accordingly is found at something less than 50 feet above them. But for the larger mirror, such a trial is impracticable (the height of the object must exceed 100 feet), and the mirrors have, therefore, been placed in the telescope without any trial, and their definition has been found perfect.

Mr. Lassell uses for polisher a wooden plate formed of two thicknesses of pine-wood with the grain crossed; and this apparently yields to accommodate itself to the form of the mirror. In the arrangement of its square protuberances, it is similar to Lord Rosse's; but it is covered with only one coating of pitch. The polishing powder used is the same as Lord Rosse's. The Astronomer Royal believed that the attentions to temperature, moisture, &c., which Lord Rosse found indispensable for his large mirrors, are not found necessary by Mr. Lassell. Mr. Lassell finishes the operation with the speculum wet.

VI. The next point to which allusion was made is the form and mounting of the telescopes.

Lord Rosse's telescope is a wooden tube, its interior diameter exceeding 6 feet in every part, being at the middle about 7 feet, and nearly 50 feet in length. This is fixed to a cube of 10 feet, which has folding-doors on that side which, when the telescope is horizontal, is the upper side (at which side the fixed frame supporting the mirror is introduced, as has already been said), and which carries the fixed frame by three large screws in that side of the cube which is opposite the mouth of the telescope. To this side of the cube is attached the universal joint by which the lower end of the telescope is connected with a fixed support, the joint being a few feet below the general surface of the ground. On each side (east and west) of the telescope is an enormous pier of solid masonry, about 70 feet long, in the north and south direction, between 40 and 50 feet high, and in its thickest part nearly 20 feet thick. (None of these dimensions are taken from actual measure.) The fixed support is nearer to the north than to the south ends of these piers. Near the top of the piers, on the interior faces, in the east and west plane passing through the universal joint, are two cranes with pulleys (the turning crane being no bigger than suffices to carry a large pulley, whose edge is in the vertical axis of the crane); over these cranes the chains pass which are attached to the telescope; and to the lower ends of the chains, after they have passed fixed pulleys on the walls, are attached the counterpoises, weighing about four tons each. These counterpoises are not allowed to depend freely, but are connected by bridle-chains with wooden horns that project from the north ends of the piers; the effect of this arrangement is that when the telescope tube is nearly horizontal and the force required to support it is very great, the weight of the counterpoises acts very nearly vertically on the chains, and is entirely effective for the support of the telescope; but when the telescope is considerably elevated and less supporting force is required, the weight of the counterpoises is supported in a great measure by the bridle-chains, and very little tension is given to the supporting chains. For the sake of supplying some slight defects in the laws of tension thus produced, and also for the sake of constantly producing a small tendency in the telescope towards the south horizon, other counterpoises, in a pit south of the fixed support, are brought successively into action as the telescope is raised. There is then only a comparatively small and very manageable tendency of the telescope towards the south, and this is supported by a light chain which passes over a pulley on a bar connecting the horns before mentioned (the pulley being in the direction of a polar axis passing through the lower universal joint, and the motion of the telescope, therefore, for a given length of the chain, being equatoreal), and this chain is shortened or lengthened, and the telescope is thereby raised or depressed, by a windlass a little way north of the fixed support. Upon the inner face of the eastern pier is an iron arc of a circle, upon which slides a runner

connected with a rod that passes through a frame on the telescope-tube and near to its mouth, and is there racked for working with a pinion : by the movement of this pinion the distance of the telescope from the pier is altered, and thus a motion in hour-angle is given. At the south ends of the piers there are strong ladders, upon which (assisted by counterpoises) there slides a stage; upon which stage a small observing box travels east and west : this is used for observing, so long as the mouth of the telescope is below the end of the pier. For greater elevations, the top of the western pier being shaped by slopes so as to approximate to a circular arc, there are mounted upon it curved galleries, which are carried by beams that run above and below pulleys fixed to the top of the pier; and the galleries are carried out by rack-and-pinion work, to approach the side of the telescope. It is intended to give the power of observing as far north as the pole; but at present the galleries extend only to the zenith. The telescope is Newtonian, the minor axis of the small mirror being about six inches, and the observer looks into the side of the tube.

Mr. Lassell's tube is of sheet iron, and this tube is not carried immediately by the mounting, but is inserted in a long box of cast iron, in which it can be turned round its own axis. This movement is necessary to place the eyepiece exactly in the same side-position in all directions of the telescope, and also to cause the edgewise support of the mirror to act always in the same way. The long box is mounted equatorially, the polar axis turning in two bearings below the declination axis, and carrying an hour-circle, upon which are fixed two supports, in which turn the two pivots of the declination axis of the long box. The telescope is Newtonian, the eyetube being in one side; but the smaller dimensions of the small mirror (a diameter of 2 inches only being required) enable Mr. Lassell to use the reflection at the internal surface of a glass prism, by which much more light is reflected than by a metallic reflector. At first much annoyance was caused by the deposition of dew on the glass, but this was remedied by attaching to it a case carrying a small piece of heated lead; and, when proper attention is given to the inclosure of the lead, no inconvenience is sustained from the effect of the hot metal in disturbing the air in the tube of the telescope. The whole is covered by a revolving dome 30 feet in diameter, and the observer is mounted for observation on a stage which is carried by the dome.

The Astronomer Royal then proceeded to describe some of the difficulties to which instruments of this class are yet liable, founded partly upon his own observations with Lord Rosse's telescope.

Upon directing the telescope to an object very near the zenith, it was seen very well defined; or, at least, with no discoverable fault. It must be remarked that the image of a star never assumes the neat spherical form to which the eye of an observer with a fine refractor is so much accustomed. This arises evidently from the circumstance that (from the great aperture of the mirror) the diffraction image and diffraction rings are invisibly small, and the

form of the blurred image is probably determined by the irregular sensibility of the nervous membranes of the eye. The same effect exactly is produced by a large refractor when a power is employed too low to exhibit the rings.

But when the telescope was directed to a star as low as the equator its image was very defective. The defect, however, followed that simple law which the present Master of Trinity College has described by the word *astigmatism*. When the eyepiece was thrust in, the image of the star was a well-defined straight line, 20 seconds long, in a certain direction; when the eyepiece was drawn out a certain distance (about half an inch from the former position) the image of the star was a well-defined straight line, 20 seconds long, in a direction at right-angles to the former. Between these two positions the image was elliptical, or, at the middle position, a circle of 10 seconds diameter. The image of *Saturn* (then without a ring) was, in the two positions above mentioned, an oval (not an ellipse), whose length was about double its breadth; or, in the middle position, it was a confused circle, whose diameter was about 30 seconds instead of 20. The position of the astigmatic lines had no distinct relation to the vertical plane; and this circumstance, as well as the magnitude of the astigmatism, proved that it was not produced by a tilt of the mirror.

Lord Rosse immediately suggested a probable cause of this defect. The triangular levers which support the mirror are all, to a certain degree, elastic. When the telescope is dropped from the vertical position, the edge of the mirror begins to press the fixed pillars in the fixed frame mentioned under No. II.; and as the edgewise pressure increases faster than the excess of the elastic force of the levers over the pressure on the levers, the edge is firmly locked to the pillars by the friction against them. When the telescope is much depressed this friction is perhaps not much less than two tons, or is equal to the greatest strain of six horses, all exerting a force perpendicular to the face of the mirror at a part intended to sustain no such force, and therefore tending to bend the mirror out of shape. The obvious remedy was to suspend the edge of the mirror in such a manner as to leave it free to play in a direction perpendicular to the face of the mirror; and for this purpose, first an iron hoop, and secondly a chain, were used, the bearing against the pillars being entirely destroyed. The effect was at first very satisfactory; definition was made very good; *Saturn's* ring was well seen on September 2 as a narrow line. But in subsequent observations the effect was not so satisfactory. Here, again, Lord Rosse discovered the cause. The triangular levers which immediately support the mirror are necessarily not plane, inasmuch as the points which take hold of the plates that adhere to the mirror must project higher (the telescope being vertical) than the fulcrum of these levers. If, then, when the telescope is lowered, the mirror is allowed to slip edgewise, it throws the lower points of each lever partly out of bearing, and then the mirror is not supported

in the way to which its figure is adapted. It was found that some of the points were not in bearing; and it was also found that, when the telescope was directed to a star, the image was rendered extremely good by screwing or unscrewing to the proper degree the supports of the hoop or chain. It was found, moreover, that all this adjustment was affected by the bending of the iron base of the fixed frame. On the whole, this part of the mounting is not in a satisfactory state. The Astronomer Royal was not able to say what is the nature of the edge-bearing adopted by Lord Rosse at the present time; still it is evident that, with due attention, the mounting above-mentioned may be made perfectly available. [The Astronomer Royal has lately been informed, that Lord Rosse has entirely overcome these difficulties, by placing, between the back of the mirror and the plates in which the points of the triangular levers act, sheets of tin, which allow the mirror to slip upon the plates, instead of the felt and pitch, which formerly united the mirror and the plates.] It may be proper here to mention, that Lord Rosse has informed the Astronomer Royal, that the mirror which he saw under the polisher has been mounted, and that it shews very well the third star of  $\gamma$  *Andromeda*,—no small proof both of the perfection of the figure and of the efficiency of the support of the mirror in that position.

The Astronomer Royal then explained his own ideas upon the nature of the mounting, to which (whatever might be the practical difficulties in the mere mechanical operation) he thought it would be necessary to approach. He thought that it was absolutely necessary to give the edge-support by counterpoises; and this might be done, retaining the present levers, by making the point of each of the small triangles a socket for a ball-and-socket joint, in which turns a lever whose point lodges in the mirror. The extreme hardness of the speculum metal makes it, however, difficult to drill the holes.

In terminating now the account of the mirror, the Astronomer Royal alluded to the impression made by the enormous light of the telescope; partly by the modifications produced in the appearances of nebulae figured by Sir John Herschel, partly by the great number of stars seen even at a distance from the Milky Way, and partly from the prodigious brilliancy of *Saturn* (the only planet which he had an opportunity of seeing). The account given by another astronomer of the appearance of *Jupiter* was, that it resembled a coach-lamp in the telescope; and this well expresses the blaze of light which is seen in this instrument.

The Astronomer Royal then stated that he had had no opportunity of trying Mr. Lassell's telescope; but he had understood from Mr. Lassell that some difficulties had been found in the arrangement of the edge-bearing of the mirror, which had been overcome by suspending it in an iron hoop. These, however, from the great difference of dimensions, would probably be trifling compared with those of Lord Rosse's mirrors.

Adverting again to the mounting of these telescopes, the Astro-

nomer Royal suggested for consideration whether it might not be advantageous to mount the telescope with an altitude and azimuth movement, by an overhanging fork inserted in a vertical pillar. If a rod were joined to the stalk of this fork, and, by means of an ordinary parallel motion, were compelled to move parallel to the axis of the telescope, and if any part of this rod were connected by another rod (adjustable in length according to the polar distance of the object) to a universal joint on the ground, in such a position that the line drawn from that universal joint to the stalk of the fork is a polar axis, then the motion of the telescope would be equatorial. For the observer, it was proposed that an observing-box should be fixed to the telescope, and that the access should be by a spiral staircase round the pillar, by a narrow platform near its top, and by a staircase along the side of the tube.

In conclusion, the Astronomer Royal observed that it was impossible to overrate the advance that had been made in the construction of telescopes by the two amateur constructors of whom he had spoken. Lord Rosse had shewn that it was possible, without any important manual labour, to produce with certainty, by means of machinery, mirrors of a size never before attained, and perhaps with a perfectness of definition which had not been reached before; and he had, by publication and by private communication, made these methods accessible to the world. This success was the more remarkable, because the whole of the work was done by workmen found on the spot; even the steam-engine, by which (to a late time) the whole of the machinery was driven, was made by native workmen under Lord Rosse's personal instructions. To Mr. Lassell also much was due, for the example which he had set of what may be done by a man possessing less ample means, and whose time is fully occupied in business; and much also for the elegant and expeditious and manageable apparatus arranged by him, which promises to be of the greatest use in the construction of large object-glasses as well as of mirrors.

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*On Irradiation.* By Professor Powell.

After adverting to the history of researches on this subject, the author dwells particularly on the method of exhibiting the phenomenon adopted by M. Plateau, which forms the basis of all his own experiments, and which consists of a card or lamina, cut so that one half of a long parallelogram is cut out whilst the other remains, having the portions at the sides cut away. Viewed against the light, the enlargement of the bright half, in breadth, is seen contrasted with the opaque, and might be subjected to measurement.

The first question on the subject refers to the supposition of a peculiar *physiological cause* affecting the eye to produce the apparent enlargement of the bright image. After fully allowing for some portion of such phenomena being fairly attributable to ocular

causes, such as dazzling, contrast, &c., experiments are adduced to shew that *precisely similar phenomena are produced in an artificial eye, or camera obscura*; whence the hypothesis of any peculiar affection of the retina is rendered unnecessary. The same conclusion is further confirmed by *photographic impressions* of the image of the card cut as before, which exhibit the same enlargement. Specimens of these impressions, taken by Mr. N. S. Maske-lyne, were exhibited.

These results, clearly pointing to an *optical cause*, agree with the conclusions of the undulatory theory, relative to the "diffraction of a lens," as investigated by Mr. Airy, which apply to the eye considered as an optical instrument, as well as to the object-glasses of telescopes; in either case *the image of a point being an extended disc*, which, if the light be bright enough, will be surrounded by rings. A luminous surface will exhibit a like enlargement.

Without reference to any theory, it is an ascertained law that the enlargement *increases with the intensity of the light*. The enlargement also is formed with a rapid decrease in brightness towards the edge. On these grounds, it is easy to explain the fact of the great diminution or total destruction of irradiation by the *interposition of lenses*, which would follow immediately from the weakening of the intensity in proportion to the square of the linear magnification. The author has examined particularly into the extent to which this effect takes place, and announces that *low powers* (from 5 to 20) *are sufficient to obliterate all irradiation even in the most intense light which the eye can bear*.

Various results of M. Plateau and others as to the effects of *contrast* in making a narrow bar or wire continue visible, though the irradiations ought to overlap, have been examined, and found only to hold good with low intensities.

The author next considers the effect in *telescopes*. Here that portion of the effect which regards the *ocular image* being placed out of consideration from the influence of the magnifying power (already referred to), we have only to consider that *part which affects the focal image* of the object-glass. The *diminution of the aperture increases the irradiation*; but at the same time it diminishes the light. At a certain point, then, these two causes counterbalance each other, and no further enlargement takes place. This limit will vary with each instrument, and we have no certain grounds on which to determine it. Various observations are referred to in which its influence is evinced.

The astronomical facts connected with these causes are then examined from the testimony of various observers. In particular the application of these principles to some of those singular phenomena occasionally noticed in eclipses, transits, occultations, &c. seems easy in theory abstractedly considered. The difficulty lies in explaining why they are observed only in some cases and not in others. The author dwells particularly on the *desirableness* of a closer attention to stating *all* the conditions of the *telescopes* employed, especially the *apertures*.

In particular the phenomenon "*the neck*," in the transits of *Mercury* and *Venus*, would be an obvious consequence of irradiation, which would diminish the planet's disc and enlarge that of the sun, except at the small portion of the circumferences in contact, when the absence of *both* irradiations would produce a "*neck*."

Both theory and experiment shew that a small dark disc would have for its image a diminished disc with a bright internal concentric ring, which, if the disc be very small, will be contracted to a central bright point. This seems to agree with the appearance noticed by several observers in the transit of a white spot on the centre of the planet. On a former occasion, however, Professor Moll and others saw such a spot *excentrical*. The projection of a star on the *bright* limb of the moon would also be an effect of irradiation, which would cause the disc of the moon simply to overlap the star.

Lastly, the author suggests a method for obtaining *measures of the amount of irradiation under any given light*, by placing a card, cut as before, at the focus of a lens, opposite to the object-glass of a telescope, and attached to it by a short tube; when the enlargement of the image of the card, illumined by the light from any source, can be subjected to the exact measurement of the micrometer of the telescope.

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*On a New Method of Observing Transits.* By A. D. Bache, Esq.,  
Director of the American Coast Survey.

"Permit me to invite your attention, and that of the members of the Royal Astronomical Society, to a brief abstract of an official report made to me on the 15th inst. by Mr. Sears C. Walker, one of the assistants of the U. S. Coast Survey. It relates to the printing, by the use of an electro-magnetic clock, in connexion with Morse's telegraph register, of the actual dates of any celestial phenomena, which are ordinarily made the subject of observation by astronomers.

"The electro-magnetic clock of Mr. Wheatston is described in the *Proceedings* of the Royal Astronomical Society for Nov. 19th, 1841. Mr. Steinheil has described his in Schumacher's *Astronomical Jahrbuch* for 1844.

"Recently Prof. Bond and Dr. Locke have invented different processes, which are described in Mr. Walker's Report.

"Prof. Bond proposes to make circuit by the metallic contact of insulated portions of the pallet and escapement-wheel. Dr. Locke, like Mr. Wheatston, uses a metallic wheel on the arbor of the seconds' hand. This wheel has sixty teeth, each of which when horizontal strikes against a platinum lever or tilt-hammer, weighing two grains. The rising and falling of the hammer from a bed of platinum breaks and makes the galvanic circuit. The fulcrum of the tilt-hammer and the platinum bed rest severally on a small block of wood.

"The object of all these methods is to cause a delicate astronomical clock to make and break the galvanic circuit every second, without injury to the machinery or rate of the clock. The mode of action of such alternations on Morse's electro-magnetic telegraph register, as now in daily use in the United States, is the same for each of these methods.

"The *automatic clock register* thus formed consists of a graduated fillet of paper delivered pretty uniformly at the rate of an inch per second. The beginnings of minutes, and fives and tens of minutes, and of seconds, and fives and tens of seconds, are distinguished from each other by the lengths of the corresponding imprinted blank spaces. The printed second consists of an indented line of about nine-tenths of a second or less, and of a blank space for the remainder. The rate of the delivery of the paper is regulated by a centrifugal clock like those of the Munich equatorials. An error of two seconds per minute in the rate of delivery causes only an average error of one-hundredth of a second in the register of a date.

"The printing of the date of any event not susceptible of automatic register, but dependent for our knowledge of its occurrence upon human sensations, is effected by tapping gently at this date on a *break circuit telegraph key*, so as to insert in the line of the *automatic clock register* a short blank space, whose beginning marks the instant of the tap. Should this blank space occur near that of the *automatic clock register*, the fact would identify its date. For isolated events the finger dwells long enough on the key to be sure of cutting off some portion of one of the indented lines. The dates susceptible of impression with advantage on the *automatic clock register* are such as the phases of an eclipse or occultation, or the bisections of a star or comet, or of a planet's centre or limb, by the wires of a transit instrument. The association of the nerves and sensations of sight and touch is known to be far more intimate than that of those of the eye and ear. The art of tapping at the proper dates requires far less practice and experience than that of counting beats and estimating fractions of a second. The labour of counting beats and of writing down the dates being here dispensed with, the equatoreal intervals of the transit wires may be reduced to two seconds of time, or even to less, and fifty bisections may now be registered in the same time as seven are in the ordinary way. The three advantages of Mr. Walker's method are respectively,—

"1st. The facility of acquirement of the practical skill for observing.

"2d. The *twofold* precision nearly of a single observation.

"3d. The *sevenfold* multiplication of observations in the same interval of time, or in the single transit of one, or the relative transits of two or more heavenly bodies.

"From all these sources it will be apparent that Mr. Walker's method of printing dates has nearly a *tenfold* advantage over the ordinary mode of using the transit instrument.

“A single transit of a star, or a night's or even a year's work by this method of printing, may take the place of some *ten* times those quantities by the method now in use.

“The experiment of printing the dates of bisections of transit wires by a star, on the ordinary registering fillet of Morse's telegraph, was made by Mr. Walker in 1846. It was repeated this last summer for some twenty or more stars, in connexion with Prof. Bond and Prof. Loomis, for a distance of some three hundred miles from Cambridge to New York. In October last, it was repeated for a like number of stars between Philadelphia and Cincinnati, in connexion with Prof. Kendall and Prof. Mitchell, through a distance of seven hundred and fifty miles. The taps made on the telegraph key at the time of bisection at each place were registered at both. In these operations, however, the ear was used to estimate fractions of a second by the *audible* beats of the telegraph and observing clocks, and no use was made of the *visible* register.

“Dr. Locke's electro-magnetic clock of his own invention and construction (Wheatston's method not being known to him at the time) was used for some two hours or more, on the 17th of November last, to make the *automatic clock register* such as is described above. The distance tried was about four hundred miles from Cincinnati to Pittsburg.

“The experiment was completely successful. The interruption of the line from Pittsburg to Philadelphia that night prevented the actual continuation of the two operations on the same fillet of paper, namely, the graduation of the paper by the automatic clock, and the reciprocal imprinting of the dates of transits of stars at the two observatories. Each process, however, has been tried by itself to a sufficient extent by Mr. Walker and his associates, to warrant his conclusions with respect to their combination, for a more full trial of which he now waits for the construction of the most approved apparatus.

“In order to make the precision of the other appendages of a transit instrument commensurate with the *tenfold* increase of that of the art of imprinting the dates of bisections for a single culmination, Mr. Walker recommends the use of a cast-iron box for the frame.

“Each side should carry three or more levels.

“The number read on each occasion should depend upon the degree of precision aimed at. The instrument should admit of rapid reversal, even on equatorial stars. For use at the station of the Coast Survey, Mr. Walker prefers to retain the micrometer adjustment of the azimuth, like that of the new Simms' transit instruments recently made for the survey.

“In the telegraph operations for longitude, two such transit instruments of moderate size are to be mounted, at any two stations, distant one or more thousand miles. All the levels are to be read with the instrument pointing to the zenith, then twenty bisections of a circum-zenith star, are to be imprinted on the *automatic clock register* previous to reversal. The like number for the same star on the same wires are to be imprinted after reversal, and the levels are again to be read.

"A similar operation is performed for the transit of the same star at the western station.

"The primitive astronomical clock may be located and rated at the central station of the Coast Survey. The *automatic clock register* may be made and kept there, even if the distance be a thousand miles from either station.

"Clock registers in any number may be made at the separate stations. The transits of two fundamental stars at remote dates, at either of the three stations, may give the rate of the primitive or central clock.

"One such transit of the same star over each station with twenty printed registers of normal bisections, and six normal levellings, with independent levels, at or near the position of actual observation, with the increased precision of the instrumental adjustments, will give in the form of a permanent printed record (with multiplied copies) the relative longitude of the two stations.

"The uncertainty of such a result need be only a few hundredths of a second, and may be such only as attends our present knowledge of the relative longitudes of Greenwich and Paris, the two oldest observatories extant.

"I avail myself of the occasion to remark, that the Coast Survey operations were completely successful this autumn between Philadelphia and Cincinnati, while actually working on the line from Philadelphia to Louisville. The distance of the line in the air is nine hundred miles, that of the circuit is eighteen hundred. I learn from an authentic source that the same success attends the use of the line from Philadelphia to the Mississippi river opposite St. Louis. The length of this circuit is *one-tenth* of the circumference of the earth. The inference from this trial is clear, that a line round the earth, if such could be constructed, might be worked with facility at one stroke. The expense of acids to supply the thousand Groves' pint cups, required for the motive power, would be about one pound sterling (five dollars) per day."

#### ERRATA.

At p. 61, paragraph 5, substitute as follows:—"General Hodgson was appointed Surveyor-General of India in May 1821, by Lord Hastings when Governor-General, but not confirmed by the Directors, who considered the patronage to be in their hands. In lieu of this, he was appointed Revenue Surveyor-General. In 1826, he was appointed Surveyor-General, and held that office till 1827, when grief for the loss of his beloved wife induced him to resign and to return to England."

P. 28, Liverpool Observations of Encke's Comet,

Oct. 10, for  $15^h 15^m 59^s$  G.M.T., read  $15^h 15^m 57^s$   
+  $36^s.80$  Corr. Eph. +  $36^s.91$

P. 29 *et seq.*, Mr. Lassell's machine is a *polishing*, not a *grinding* machine.

P. 46, March 26, for  $29^h$ , read  $20^h$ .

P. 47, Dec. 21, 2d Observation, for  $-0^s.23$ , read  $-0^s.83$

Dec. 23, 2d — —  $-1^s.00$ , —  $-1^s.10$

Jan. 15, delete the first four lines which are repeated;  
towards the bottom, for five transits, read six.

P. 48, line 7, for six, read two; and for Jan. 11, read Jan. 15.

# ROYAL ASTRONOMICAL SOCIETY.

VOL. IX.

April 13, 1849.

No. 6.

G. B. AIRY, Esq., Astronomer Royal, President, in the Chair.\*

Thomas Dell, Esq., Aylesbury;

Wm. Garrow Lettsom, Esq., British Legation, Washington;

Wm. Rutter, Esq., Haverstock Hill;

Edward Ryley, Esq., Leadenhall Street; and the

Rev. Charles Pritchard, Clapham;

were balloted for and duly elected Fellows of the Society.

The New Tables of the Sun, begun by Bessel and continued by Professor Hansen, are now completed. Professor Schumacher hopes they may be published this year.

## NEW COMET.†

On the 14th of April, at 10<sup>h</sup> 30<sup>m</sup> P.M., Mr. Graham, of the Markree Observatory, discovered a comet in the constellation *Bootis*, not far from  $\alpha$ .

The following observations, are corrected for aberration and parallax:

Greenwich M.T.			
	$\delta$	$\alpha$	$\delta$
1849.			
April 14.48780	222 21 14	+ 27 40 16	
16.51120	217 53 6	26 38 4	
19.51041	209 22 58	+ 24 5 26	

From which Mr. Graham has deduced these elements,—

Perihelion Passage, 1849, June 8.238, Greenwich M.T.

$$\left. \begin{array}{l} \alpha = 266^{\circ} 59' 12'' \\ \delta \quad 30^{\circ} 29' 38'' \\ i \quad 67^{\circ} 11' 45'' \end{array} \right\} \text{App}^{\dagger} \text{Eq}^{\times} \text{April 17.}$$

Log.  $q = 9.95214$  Motion Direct.

\* A memoir was read, "On the Computation of the Orbits of Double Stars," by Sir John Herschel, with some remarks by the President, which will appear in the next *Notice*.

† In a letter received from Professor Schumacher, we are told that this comet was previously discovered by Professor Schweizer at Moskow.

## CAMBRIDGE, U.S.

(Professor Bond.)

1849.	Cambridge M.T.	R.A.	Dec.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>o</sup> <sup>'</sup> <sup>"</sup>
April 11	10 56 29	15 9 6.11	+28 33 27.0
12	7 57 58	15 3 36.28	28 20 9.1
14	10 35 59	14 48 12.14	27 36 33.7
17	8 48 52	14 20 40.60	+25 54 23.4

Referred to the Mean Equinox, Jan. 1, 1849.

"The comet has a strong starlike central condensation, an extensive coma, and no tail."

*Approximate Ephemeris.* By Mr. Graham.For 8<sup>h</sup> P.M. Greenwich M.T.

1849.	R.A.	N.P.D.	1849.	R.A.	N.P.D.		
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>o</sup> <sup>'</sup> <sup>"</sup>		<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>o</sup> <sup>'</sup> <sup>"</sup>		
April 23	12 58 15	71 57	May 4	9 26 18	103 51		
24	39 51	74 11	5	9 11 32	105 54		
25	12 20 16	76 51	6	8 58 1	107 44		
26	11 59 51	79 50	7	45 40	109 20		
27	39 6	82 59	8	34 20	110 45		
28	11 18 4	86 15	9	23 58	111 58		
29	10 57 22	89 32	10	14 31	113 3		
30	37 12	92 47	11	8 5 50	114 1		
May 1	10 17 45	95 54	12	7 57 49	114 47		
2	9 59 25	98 49	13	50 30	115 31		
3	42 14	101 28	14	7 43 55	116 11		
	Hor. Par.	Hor. Par.		Hor. Par.	Hor. Par.		
April 23	36.3	April 29	41.3	May 5	33.4	May 10	25.6
24	38.0	30	40.7	6	31.8	11	24.4
25	39.3	May 1	39.7	7	30.1	12	23.3
26	40.4	2	38.3	8	28.5	13	22.4
27	41.1	3	36.8	9	27.1	14	21.1
28	41.5	4	35.0				

## GOUJON'S NEW COMET.

This comet was discovered by M. Goujon, of the Paris Observatory, on April 15th. Mr. Hind has favoured us with the following apparent places, *uncorrected* for parallax :—

1849.	Greenwich M.T.	R.A.	Dec.	
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>o</sup> <sup>'</sup> <sup>"</sup>	
April 15	10 45 30	167 6 59.4	-25 31 26.2	Goujon.
17	10 22 27	166 40 29.3	19 31 20.2	Hind.
20	10 49 3	166 7 47.4	9 34 44.3	Hind.
21	9 56 32	165 59 16.1	-6 14 56.3	Borcham.
23	11 59 56	165 44 10.3	+0 56 12.9	Hartnup.

## IRIS.

LIVERPOOL.				Equatoreal.		(Mr. Hartnup.)		
1849.	Greenwich M.T.				R.A.	N.P.D.	Comp <sup>d</sup> —Observ.	
	h	m	s				R.A.	N.P.D.
Mar. 6	10	35	31.5	9 38 10.80	84 53 5.8	—1.60	+2.1	a
8	11	1	4.6	36 41.10	42 39.7	1.64	3.2	a
9	10	48	27.2	35 59.16	37 36.5	1.63	4.1	b
16	9	50	33.9	31 47.75	84 4 4.0	1.88	6.1	c
17	10	3	11.1	31 17.88	83 59 32.7	2.00	5.1	c
24	10	32	16.4	28 37.20	30 46.9	1.96	3.4	c
27	8	51	39.5	27 55.54	20 22.1	2.13	3.8	c
31	9	7	4.9	27 22.30	7 47.1	2.10	2.4	d
April 1	10	47	44.3	27 17.96	83 4 45.9	1.99	1.6	d
3	10	40	11.0	27 15.25	82 59 30.4	1.97	1.2	d
11	11	10	40.4	28 8.70	43 23.7	1.88	1.2	d
14	9	8	58.0	28 52.67	39 31.0	1.92	3.7	d
15	8	56	52.4	9 29 10.27	82 38 28.2	—1.76	+3.0	d
a	3295, 3412				B.A.C.		c	3203, 3359
b	3295, 3359				—		d	3228, 3386
								B.A.C.

"The places of the stars of comparison are taken from the catalogue cited. The observed places are corrected for refraction and parallax. The computed places are deduced from the ephemeris of MM. Hind and Pogson, which is printed in the *Monthly Notice*, vol. ix. No. 5."

## HEBE.

*Ephemeris* for 8<sup>h</sup> P.M. Greenwich Mean Time.

Taken from M. Luther's *Ephemeris* in the *Astronomische Nachrichten*, by permission of Professor Schumacher.

1849.	R.A.				N.P.D.	1849.	R.A.				N.P.D.
	h	m	s				h	m	s		
April 20	6	44	46.03	70 44 33.8		May 11	7	17	39.16	70 9 32.1	
21		46	15.87	41 49.2		12		19	16.80	9 1.5	
22		47	46.19	39 11.1		13		20	54.69	8 37.2	
23		49	17.00	36 39.5		14		22	32.83	8 18.9	
24		50	48.27	34 14.5		15		24	11.23	8 6.6	
25		52	20.00	31 56.0		16		25	49.87	8 0.5	
26		53	52.18	29 44.0		17		27	28.73	8 0.5	
27		55	24.77	27 38.5		18		29	7.83	8 6.4	
28		56	57.78	25 39.5		19		30	47.15	8 18.3	
29	6	58	31.19	23 46.9		20		32	26.68	8 36.2	
30	7	0	4.98	22 0.8		21		34	6.40	9 0.1	
May 1		1	39.16	20 21.1		22		35	46.31	9 29.8	
2		3	13.70	18 47.8		23		37	26.41	10 5.4	
3		4	48.58	17 20.8		24		39	6.68	10 46.8	
4		6	23.81	16 0.2		25		40	47.13	11 34.0	
5		7	59.38	14 46.0		26		42	27.73	12 27.0	
6		9	35.26	13 38.0		27		44	8.47	13 25.7	
7		11	11.45	12 36.4		28		45	49.35	14 30.0	
8		12	47.95	11 41.0		29		47	30.38	15 40.1	
9		14	24.74	10 51.8		30		49	11.51	16 55.7	
10	7	16	1.81	70 10 8.8		31	7	50	52.76	70 18 16.9	

Reckoned from the true equinox and corrected for aberration.

Horizontal Parallax.					
April 20	3 <sup>h</sup> 3'	May 6	3 <sup>h</sup> 0'	May 22	2 <sup>h</sup> 8'
24	3 <sup>h</sup> 2'	10	3 <sup>h</sup> 0'	26	2 <sup>h</sup> 8'
28	3 <sup>h</sup> 1'	14	2 <sup>h</sup> 9'	30	2 <sup>h</sup> 7'
May 2	3 <sup>h</sup> 1'	18	2 <sup>h</sup> 9'		

### Observations of Wilmot's Comet. By Mr. Maclear.

Mr. Maclear's absence from the Observatory, while engaged in the measurement of an arc of the meridian, has occasioned a considerable delay in reducing the observations of this comet.

The places of the comet are corrected for refraction, and the log. factor is annexed to each, which, when added to the log. hor. parallax in seconds of space, will give the log. correction in right ascension and north polar distance, in time and arc respectively.

The catalogue of the stars of comparison is appended.\*

#### CAPE OF GOOD HOPE.

(Mr. Maclear.)

	Cape M.T. h m s	R.A. h m s	Log. Fact.	N.P.D. ° ' "	Log. Fact.	Obs. Star.
1844. Dec. 24	8 17 29	19 43 11 <sup>h</sup> 86	+8 <sup>h</sup> 8384	128 12 17 <sup>h</sup> 1	+9 <sup>h</sup> 7346	2 1
27	8 14 23	20 16 49 <sup>h</sup> 16	8637	131 3 41 <sup>h</sup> 0	6756	10 2
	8 37 35	17 0 <sup>h</sup> 34	8571	131 4 27 <sup>h</sup> 7	7221	10 3
28	8 19 14	28 30 <sup>h</sup> 05	8707	131 50 48 <sup>h</sup> 8	6413	10 4
	9 7 33	28 58 <sup>h</sup> 68	8519	131 52 36 <sup>h</sup> 5	7601	8 4
30	8 38 34			133 10 14 <sup>h</sup> 1	6644	6 5
	8 38 57	52 54 <sup>h</sup> 72	8781			7 5
	9 6 2	53 8 <sup>h</sup> 60	8699			9 6
	9 6 30			133 11 0 <sup>h</sup> 9	7239	8 6
	9 31 50	20 53 22 <sup>h</sup> 03	8562	133 11 24 <sup>h</sup> 8	7706	6 5
31	8 31 24	21 5 14 <sup>h</sup> 12	8838	133 41 11 <sup>h</sup> 1	6232	10 7
	9 8 33	5 33 <sup>h</sup> 21	8759	133 41 54 <sup>h</sup> 3	7090	10 7
1845. Jan. 1	8 42 57	17 52 <sup>h</sup> 05	8867	134 6 43 <sup>h</sup> 3	6279	9 8
3	9 20 28	21 43 32 <sup>h</sup> 37	8876	134 40 29 <sup>h</sup> 4	6733	5 9
5	9 58 45	22 9 13 <sup>h</sup> 66	8819	134 50 48 <sup>h</sup> 0	7178	7 10
6	8 14 9	20 52 <sup>h</sup> 14	8762	134 47 45 <sup>h</sup> 7	3761	10 11
	9 9 6	21 20 <sup>h</sup> 25	8920	134 47 37 <sup>h</sup> 7	5745	10 12
	9 34 12	21 33 <sup>h</sup> 45	8909			12 11
	9 45 58			134 47 21 <sup>h</sup> 8	6710	12 11
	10 3 6	21 48 <sup>h</sup> 59	8832			12 11
9	9 1 59	57 46 <sup>h</sup> 20	8809	134 7 3 <sup>h</sup> 5	4821	12 13
	9 25 21	57 57 <sup>h</sup> 78	8861			10 13
	9 40 13			134 6 29 <sup>h</sup> 2	+9 <sup>h</sup> 5977	14 13
	9 58 20	22 58 13 <sup>h</sup> 79	+8 <sup>h</sup> 8859			8 13

\* The columns R.A. Comet—R.A. Star; and N.P.D. Comet—N.P.D. Star, are omitted, though given by Mr. Maclear.

Observations of Wilmot's Comet.

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1845.		Cape M.T.			R.A.	Log. Fact.	N.P.D.	Log. Fact.	Obs.	Star.
		h	m	s	h	m	°			
Jan.	11	9	24	12	23 20 52.27	+8.8769	133 16 47.8	+9.5120	10	14
	12	9	14	46	31 46.43	.8678	132 46 3.1	.4615	10	15
		9	54	17	23 32 3.50	.8771	132 45 17.5	.5860	10	16
	15	9	26	43	0 2 28.99	.8522	130 54 35.8	.4619	10	18
		9	58	4	2 40.56	.8624	130 53 49.8	.5596	10	17
	16	10	34	4	12 20.42	.8601	130 10 32.7	.6378	14	19
	17	10	13	24	21 15.02	.8540	129 27 9.0	.5846	6	20
	18	9	41	9	29 43.50	.8376	128 42 36.9	.4873	15	21
	19	9	49	12	38 4.28	.8347	127 55 25.6	.5077	1	22
		10	19	42	0 38 15.38	.8442	127 54 26.0	.5898	2	22
	22	9	4	24	1 0 39.50	.7824	125 31 34.0	.3660	10	23
		9	55	28	0 54.76	.8189	125 29 51.0	.5220	10	23
	24	9	3	13	14 17.40	.7668			12	24
		9	21	26			123 52 10.0	.4328	16	24
		10	12	54	14 36.41	.8154			12	24
	25	8	54	28	20 38.21	.7504	123 3 39.1	.3581	10	25
		9	30	23	20 47.48	.7851	123 2 23.7	.4642	10	26
	27	9	49	2	32 49.33	.7878	121 23 37.6	.5227	8	27
	28	9	41	9	38 24.33	.7775	120 35 31.2	.5104	12	28
	29	9	41	14	43 47.05	.7726	119 47 20.1	.5174	12	29
	30	9	51	33	48 59.60	.7760			12	30
	31	9	38	0	53 55.49	.7620			16	31
		10	1	9			118 12 39.4	.5713	16	31
		10	25	23	54 5.35	.7897			16	31
Feb.	1	9	39	6	58 42.56	.7591			12	32
		10	0	54			117 26 35.5	.5765	10	32
		10	23	5	1 58 51.47	.7854			12	33
	3	9	28	17	2 7 42.89	.7432			16	33
		9	49	55			115 57 10.7	.5697	14	33
		10	12	25	7 51.07	.7744			16	33
	4	9	10	9	11 57.32	.7216			16	34
		9	32	3			115 13 58.5	.5462	16	34
		9	53	24	12 5.26	.7603			16	34
	8	9	8	5			112 28 14.6	.5426	10	35
		9	34	33	27 45.67	.7366			30	35
		9	58	15			112 26 46.9	.6163	10	35
	9	9	12	28	31 20.25	.7133			16	36
		9	30	19			111 48 6.8	.5819	12	36
		9	51	45	31 26.21	.7481			16	36
	10	9	25	55	34 52.63	.7254			14	37
		9	44	26			111 9 6.7	.6088	14	37
		10	6	29	34 58.50	.7556			8	37
	16	8	56	57	2 53 55.80	+8.6896			12	39
		9	10	60			107 35 38.9	+9.6097	10	39

*Catalogue of Mean Right Ascensions, &c.*

1845.		Cape M.T.			R.A.	Log. Fact.	N.P.D.	Log. Fact.	Obs.	Star.
		h	m	s	h	m	°	'		
Feb.	16	9	24	24	2 53	59'66		+8'7188		12 39
	18	8	54	11	59	40'78		·6864		12 40
		9	17	13			106	30 24'9	+9'6285	10 40
		9	37	34	2 59	45'76		·7305		12 40
	27	8	19	16	3 22	32'18		·6476		20 41
		8	40	56			102	12 51'5	·6503	12 41
		9	2	56	22	36'89		·7014		20 41
	28	8	30	7	24	52'27		·6647		12 42
		8	46	22			101	47 14'6	·6586	12 42
		9	2	8	24	54'93		·7016		12 42
Mar.	4	9	0	50			100	10 29'9	·6687	10 43
		9	20	50	33	47'16		·7209		18 43
	5	8	48	1	35	52'63		·6933		18 44
		9	8	43			99	47 39'5	·6910	10 44
	6	8	57	18	37	58'38		·7037		16 45
		9	13	12			99	25 17'0	·6965	10 45
	9	8	20	25	44	2'21		·6687		24 46
		8	49	43			98	21 51'3	·6953	12 46
	12	8	25	49	3 49	55'75		+8'6811		20 47
		8	46	5			97	22 16'9	+9'7038	14 47

*Catalogue of the Mean Right Ascensions and North Polar Distances of the Stars compared with Wilmot's Comet.*

Star's No.	Mag-nitude.	R.A.			Annual Precess.	No. of Obs.	N.P.D.			Annual Precess.	No. of Obs.
		h	m	s			°	'	s		
1		19	42	26'93	4'014	9	128	3	11'8	8'67	3
2	8	20	16	24'71	4'030	7	130	54	46'4	11'24	5
3	9	17	15	28	4'035	4	131	8	20'3	11'30	4
4	Lacaille 8497	7	27	22'86	4'026	11	131	45	30'7	12'03	6
6		51	43	50	3'973	8	132	40	48'2	13'66	4
5	Lacaille 8638	8	20	52 0'57	4'002	7	133	35	43'9	13'68	9
7		21	5	55'50	3'947	9	133	35	42'7	14'54	6
8	Lacaille 8822	7'8	19	49'58	3'906	15	134	10	41'8	15'35	10
9		21	44	27'08	3'804	8	134	31	37'3	16'65	5
10		22	7	5'47	3'692	10	134	30	20'8	17'67	8
12	δ Gruis	20	28	28	3'624	15	134	32	21'6	18'19	5
11	B.A.C. 7834	7	21	25'28	3'626	6	134	53	9'6	18'23	6
13	θ Gruis	22	58	7'42	3'419	14	134	21	20'5	19'33	12
14	B.A.C. 8186	8	23	22 10'92	3'274	20	132	50	20'8	19'78	15
16		33	12	44	3'213	13	132	26	21'0	19'92	11

Star's No.		Mag- nitude.	R.A. 1845, Jan. 1.			Annual Precess.	No. of Obs.	N.P.D. 1845, Jan. 1.			Annual Precess.	No. of Obs.
			<sup>h</sup>	<sup>m</sup>	<sup>s</sup>	<sup>+</sup>		<sup>o</sup>	<sup>'</sup>	<sup>"</sup>	<sup>+</sup>	
15	B.A.C. 8242	7.8	23	33	41.93	3.214	6	133	7	34.5	19.92	4
17	Lacaille 9739	8	0	1	5.62	3.065	9	130	35	58.4	20.05	8
18	Lacaille 9757	8		3	26.93	3.053	6	131	14	6.9	20.05	9
19	Lacaille 50	7.8	13	10	70	3.006	9	130	5	57.2	20.02	6
20	Lacaille 126	8.9	26	2	46	2.945	7	129	32	24.9	19.93	5
21	B.A.C. 144	8	27	5	20	2.944	5	128	51	4.8	19.91	8
22	Lacaille 216	8	40	6	80	2.890	7	127	46	21.4	19.75	13
23	Lacaille 304	7.8	0	59	0.63	2.827	10	125	37	42.6	19.39	10
24		8	1	14	28.18	2.782	14	124	2	48.8	19.01	7
25		7	19	49	64	2.770	13	123	20	55.0	18.85	9
26		8.9	21	45	06	2.769	5	122	50	33.5	18.79	7
28		9	36	43	60	2.747	7	120	35	45.3	18.29	3
27		9	36	53	32	2.734	6	121	30	32.8	18.29	8
29	Lacaille 535	8	42	53	18	2.738	13	119	48	42.7	18.07	6
30		9.10	48	28	39	2.740	6	118	28	28.1	17.85	6
31		9	52	43	81	2.732	6	118	13	34.8	17.68	5
32		8.9	1	55	31.57	2.734	7	117	29	29.4	17.56	6
33		10	2	6	29.92	2.728	7	116	3	43.3	17.08	3
34		9	12	57	26	2.726	4	115	11	41.4	16.77	5
35	Lacaille 787	7.8	27	31	74	2.736	11	112	36	34.1	16.04	8
36		8.9	31	30	45	2.744	9	111	42	42.1	15.83	10
37		8.9	35	31	75	2.745	4	111	12	3.4	15.61	5
39	Lalande 5621	8	2	54	9.97	2.774	6	107	51	1.0	14.54	4
40		9	3	2	6.59	2.786	6	106	36	32.0	14.05	3
41	Lalande 6492	7.8	22	50	24	2.847	13	102	10	42.9	12.70	10
42	Weisse iii, 476	8	25	51	45	2.854	7	101	42	9.1	12.49	5
44	Weisse iii, 650	8	33	53	66	2.887	12	99	41	43.9	11.94	5
43	δ Eridani	3.4	35	49	58	2.874	9	100	17	31.5	11.80	3
45	Weisse iii, 746	7	38	28	57	2.888	12	99	29	49.3	11.61	2
46	Lalande 7246	7	47	10	74	2.906	10	98	22	1.6	10.98	6
47	Lalande 7370	7	3	50	37.19	2.904	7	97	23	33.2	10.73	4

## On the Form of the Planet Saturn. By the Rev. R. Main.

Sir W. Herschel, from repeated estimations with various telescopes made with the greatest care (and assuredly with the most practised eye and unbiassed judgment ever brought to such a task), convinced himself that the figure of *Saturn* was not elliptical, but "like a parallelogram with the corners rounded off." He was also

of opinion that the northern and southern polar regions were of a very different shape. This latter opinion was also held by his son, Sir John Herschel. The disappearance of the ring, which happened towards the end of last year, induced Mr. Main to undertake a large series of micrometrical observations, which confirmed the impression he had received from mere inspection, that the form of *Saturn*, without his ring, is a perfect ellipse of considerable ellipticity.

The observations were made with the large telescope by Cauchoix, mounted equatorially, and the divided eye-piece micrometer. Up to October 25, 1848, the eye-piece was used which is described in the *Greenwich Observations*, 1840, *et seq.*, and after that time an improved eyepiece, on the same principle, was employed. This latter construction, which is greatly preferred by Mr. Main, as giving each image equally good in every part of the field and with better definition, is described by the Astronomer Royal in vol. xv. of our *Memoirs*. The results of the two micrometers seem, however, of equal value.

Mr. Main gives, in full detail, measures of the planet in and near the polar and equatorial diameters, and in and near the intermediate directions. After shewing that a slight error in the assumed angular direction of the pole cannot sensibly affect the ellipticity, Mr. Main gives the following table of the measures of the diameters reduced to arc at a mean distance, log. = 0.95.

Apparent Diameters of *Saturn* : Distance = [0.95.]

		Equatorial.	Polar.	Inclined.	Transverse.
1848. Sept.	6	19.16	16.83	"	"
	18	18.82	16.66		
	19	18.65	16.78		18.00
	20	18.53	16.46	17.32	17.70
	22	18.75	16.44	17.58	17.58
Oct.	5	18.84	16.44	17.29	17.53
	9	18.41	16.34	17.41	17.46
	25	18.62	16.54	17.34	17.78
Nov.	15	18.18	16.58	17.41	17.76
	21	18.65	16.77	17.60	17.90
1849. Jan.	26	18.83	16.77	17.92	18.33

Mr. Main remarks, 1st, That the absolute measures vary on different evenings considerably beyond the limits of the probable errors of the observations, for which the only obvious cause seems to be a change in atmospheric circumstances. 2. That the change seems to affect the measures in all directions pretty equally, except that the measures of the polar diameter seem somewhat more consistent, which may be due to the lateral tremor produced by the clock-work, or to the air being more disturbed horizontally than vertically.

From the above measures, adopting a formula supplied by the Astronomer Royal, Mr. Main finds the ellipticity, or  $\frac{a-b}{a}$  ( $a$  and  $b$  being the observed equatoreal and polar diameters) = 0.10925 with probable error 0.00081; or ellipticity =  $\frac{1}{9.153}$ .

Mr. Main then reduces his measures of the inclined diameters to what they would have been if the two sets had been measured respectively at exactly  $45^\circ$  to the direction of the axis of the ring given in the *Nautical Almanac*, and finds that they are then perfectly equal. As a further proof of the perfect ellipticity of *Saturn*, Mr. Main shews that the mean of the polar and equatoreal measures is equal to the mean of the inclined measures, which should be the case, as far as the second powers of the eccentricity.

The final value of the arc subtended by the equatoreal diameter of *Saturn*, when the log. distance = 0.95, is  $18''.73$ , and that subtended by the polar diameter at the same distance is  $16''.68$ .\*

*Some Remarks on the Method of the Astronomer Royal for ascertaining the Difference between the true and spurious Disc of Venus.* By Mr. Sheepshanks.

"Having understood from Mr. Adams, that he wanted some good measures of the diameter of *Venus*, I wrote to Mr. Hartnup, requesting him to apply his equatoreal to that planet. In three or four days I received the following answer:—

'Wire Micrometer, Means of 10 Measures.

Feb. 27	<sup>d</sup>	<sup>h</sup>	<sup>m</sup>		Diameter =	24.66,	Power 400
28	5	11,		„	=	24.69,	„ 180

'Double Image Micrometer, Means of 5 Double Measures.

Feb. 27	<sup>d</sup>	<sup>h</sup>	<sup>m</sup>		Diameter =	23.38,	Power 161
28	5	40,		„	=	23.62,	„

" 'I cannot,' continues Mr. Hartnup, 'at present account for the difference between the wire-micrometer and the divided eyepiece, can you suggest anything which I can do to find it out?'

"On thinking the matter over, I hit upon a plan which I shall shortly explain; but I learned from the Astronomer Royal, that he had used the same method eleven years ago for correcting the disc of *Venus*, and had fully developed it in the volume of *Greenwich Observations* for 1838, page lii.

"I have still thought the subject worth bringing before the Society; first, because the *Greenwich Observations* are not read as carefully or as extensively as they ought to be (witness my own

\* Hence at distance 1, Equatoreal Semidiameter =  $83''.46$   
Polar ..... =  $74''.34$

ignorance and that of Mr. Hartnup); and secondly, because the Astronomer Royal has only insisted upon that use of the principle which his own observations required. *Venus* may now be observed very easily; and if the following remarks are just, measures of *Venus* may be employed to give a careful observer much insight into the defects of his telescope, as well as into his own personal qualities and errors.

“It is well known that a bright object, viewed even by the best telescope, appears under an angle somewhat larger than it ought to do; which increase differs, probably, according to various circumstances. A bright image on the retina seems to extend its influence beyond its immediate locality. This is, if I mistake not, generally called irradiation. Again, from the principles of the undulatory theory, the image of a bright point is always of some extent, and is all the larger, the smaller the aperture of the object-glass or mirror in respect to its focal length. Lastly, any defect, such as spherical aberration (which is usually largest in large apertures and short foci), tends to increase the image. It is, therefore, somewhat puzzling to say what the *true* subtended angle in any case is, and difficult to reconcile the statements of different astronomers with different telescopes and under differing conditions. Passing by irradiation for the moment, let us first see how a spurious disc from the other causes mentioned may be reduced to the true disc by the method suggested by the Astronomer Royal.

“Make careful measures of the diameter of *Venus* (with a wire-micrometer or a double-image micrometer), when she is nearest the earth, and also when she is most distant. These measures are best made in daylight, as there is then little or no irradiation, and the limb is seen most steadily. It is easy to get two sets of observations in which the respective distances of *Venus* and the earth are as 1 : 4; and it is evident that the errors from the undulatory theory, a defective object-glass, &c., will alter the apparent disc of the planet by the *same* angular amount, whether the planet be seen under a large or a small angle. Let the true diameter of *Venus* at distance 1 =  $\theta$ , and let the observed diameters at distances  $d, d'$ , &c. be  $\phi, \phi'$ , &c.; also let the spurious increase be  $e$ , either from the causes above mentioned, or an erroneous habit of making the measure.

Then

$$\frac{\theta}{d} + e = \phi, \quad \frac{\theta}{d'} + e = \phi'$$

in which  $\theta$  and  $e$  are the only unknown quantities: these are found very accurately, when  $d$  and  $d'$  differ very much. (The effect of a bad habit of measuring with the wire-micrometer, or in forming the contacts with a divided eyepiece, is got rid of by the above process, that is to say, it is lumped with the spurious disc.)

“To ascertain the effect of irradiation, measure the planet in the daytime, and at night when brightest. The difference in these measures is due, probably, to irradiation. Measure again, throwing in all the light you can, and using as dark a glass as will allow

satisfactory vision. It will soon be seen to what extent irradiation increases the apparent diameter. What is left of irradiation in daylight, may be eliminated when the law is determined which connects the phenomenon of irradiation with intrinsic brightness and the effect of additional light on the retina.

"If measures of *Venus* point out any defect in a telescope and the law of that defect, the rule so obtained will apply to all other measures of the moon, planets, &c., by the same person with the same telescope. And if such an inquiry does not lead to consistent results, it would seem to follow that there are in telescopes errors other than we have been accustomed to suspect, and obeying different laws.

"The great intrinsic brightness of *Venus* and her manageable diameter make her far fitter for experiments on irradiation than the sun or moon, which can only be compassed by a heliometer."

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*Observations of Solar Spots at Mr. Lawson's Observatory, Bath.*

By Mr. E. J. Lowe.\*

"As the solar disc during the last few days has exhibited some remarkable phenomena, I send an abbreviated account made with the 11-foot refractor; several powers were used, but 55 was the usual one.

"The spots are distinguished as B, C, and A, and their relation to the centre of the sun is expressed by co-ordinates through his centre, *a* above, *b* below, *r* right, *l* left. When a spot is near the edge it is more convenient to refer it to the edge, and the word *edge* means that the spot is as far from the edge as the figures denote. The direction refers to the sun as seen in an inverting telescope. The figures and fractions are in digits and fractions of a digit.

\* In reply to some inquiries, Mr. Lowe informed the Editor that observations of solar spots at the Bath Observatory are made thus:—A reticule of small squares is used as a micrometer, each interval being, very nearly, half a digit, or  $\frac{1}{2}$  of the sun's diameter. These spaces, which are about 80'', are, in the language of the Bath Observatory, each called 7°, *i. e.* supposing the sun's diameter about 180°. The mode of registering the observations is very simple and neat. For every observation there is an engraving, in which the reticule wires are represented and numbered, so that when the sun is brought into its proper place in the telescope, each spot is referred at once to its own square in the drawing. For details, a larger system of squares is engraved below the reticule; in these the remarkable spots are carefully drawn, and referred to their proper places by letters. Mr. Lawson's telescope has 7 inches aperture (a very fine glass by Dollond), and is equatorially mounted, with clock-work. The position of the spots is noted with a power of 55 applied to *Lawson's Solar Eyepiece*, which takes in the whole image of the sun; the details are completed with other powers. There is, besides, a 5-foot telescope on a stand, with a vertical and horizontal motion. Mr. Lawson has sent 10 drawings on days referred to in this paper.

	Bath M. T.		B.	C.	A.
	<sup>h</sup>	<sup>m</sup>			
Feb. 23	0	0	$1\frac{1}{2} a$	$2\frac{1}{2} b, \frac{1}{2} r$	
24	1	30	$2\frac{1}{2} a, \frac{1}{2} r$	$1\frac{1}{2} b, \frac{1}{2} l$	5 <i>edge.</i>
25	2	30	$3\frac{1}{2} a, \frac{1}{2} l$	$\frac{1}{2} b, 1\frac{1}{2} l$	$5\frac{1}{2} b, \frac{1}{2} \text{ edge.}$
25	23	30	$3\frac{1}{2} a, 2 l$	$1 b, 2 l$	4 <i>b, 1 edge.</i>
27	0	0	4 <i>a, 3\frac{1}{2} l</i>	$\frac{1}{2} b, 3\frac{1}{2} l$	3 <i>b, \frac{1}{2} l</i>
28	22	0	3 <i>a, \frac{1}{2} edge.</i>	$\frac{1}{2} b, 1 \text{ edge.}$	
March 1	23	30	Disappeared.	$\frac{1}{2} a, \frac{1}{2} \text{ edge.}$	$1\frac{1}{2} b, \frac{1}{2} r$

" 1849, February 23, 0<sup>h</sup>. A very large spot, the *umbra* of which was  $\frac{1}{2}$  digit in length and  $\frac{1}{3}$  in breadth, surrounded with much *penumbra*, was situated with its lower edge  $1\frac{1}{2}$  digits perpendicularly above the sun's centre (inverted eye-piece); this, for distinction's sake, we shall call B; also a mass of *penumbra* (C, with no large *umbra*) of  $1\frac{1}{2}$  digits in length, and  $\frac{1}{4}$  in breadth, about  $2\frac{1}{2}$  digits perpendicularly below the sun's centre, and  $\frac{1}{2}$  to the right. There were other smaller spots and clusters. The corrugations were very strong, and extended more or less all over the sun's disc, being most marked in the E. and W.

" Feb. 24, 1 $\frac{1}{2}$ <sup>h</sup>. The spot B had not moved with the rotation of the sun, but had retrograded  $\frac{1}{4}$  digit, it is  $2\frac{1}{2}$  digits above the sun's centre. The mass C had moved with the motion of the sun. At 5 digits below the centre of the sun, a notch of  $\frac{1}{2}$  digit in length was cut out of the edge of the sun. In an hour's time the notch had sensibly increased. Clouds prevented further observation.

" Feb. 25, 2 $\frac{1}{2}$ <sup>h</sup>. The indentation in the edge of the sun has disappeared, but a spot A, of great dimensions, is situated  $\frac{1}{4}$  digit from the sun's edge, which accounts for the notch seen yesterday.\* The motion of the spot B is again direct. C is becoming less dense.

" Feb. 26, 1 $\frac{1}{2}$ <sup>h</sup>. A remarkable occurrence with respect to the spot B took place; it was first noticed by Lieut. Hardy, who called my attention to it. The *umbra*, which was of an elongated form, opened in the centre, and so divided it into two parts; it always opened from the lower edge, and was alternately open and closed at intervals of 15<sup>s</sup>; this was very sensible, and the experiment of marking the time which elapsed between the openings was repeated many times. The *penumbra* did not change its form. A is a fine single spot.

" Feb. 27, 0<sup>h</sup>. Spot B had divided into two spots at that part where the partial openings were yesterday, and the lower spot of the two had become smaller. At 0<sup>h</sup> 10<sup>m</sup> it was noticed that this

\* "I find the following entry in Mr. Lawson's observatory-book:—'Camberwell, 1846, June 30. Viewed the sun through the fine achromatic just completed by Mr. Dollond, of 12 inches clear aperture. (The whole aperture was used by means of 'Lawson's Solar Eye-piece.') Saw the limb of the sun notched. In about two hours the notch or indentation had disappeared, and a large spot was visible. All agree as to the appearance of the notch on the limb of the sun; powers used were 70 and 150. Signed, G. DOLLOND, G. HUGGINS, and H. LAWSON.'"

smaller spot also opened from beneath in the way that the whole spot had done yesterday, only those openings took place every minute, remaining open from 5<sup>s</sup> to 8<sup>s</sup> of time. These separations were observed ten times during as many minutes, when this phenomenon ceased at this part of the spot, but the division between the spots now alternately enlarged, and partially closed, at intervals of a minute, remaining widely open each time from 5<sup>s</sup> to 8<sup>s</sup>. At several periods the two spots appeared to overlap each other, for they joined, and the edge of the smaller spot was indented. At 0<sup>h</sup> 30<sup>m</sup> the oscillations were abating; clouds came over. The spot A had also become divided since yesterday, and shewed signs of a further division, for in the lower of the two spots were two indentations, the one above and the other beneath. 1<sup>h</sup> 7<sup>m</sup>. Again sunshine. The lower spot in A divides at intervals of 30<sup>s</sup>, and closes again. There was also thought to be a light flowing from behind the *penumbra* at the upper edge.\*

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*Extract of a Letter from W. S. Jacob, Esq. inclosing two Sheets of Diagrams of Solar Spots observed at Poona, in December 1848, and January and February 1849.*

"I beg to call your attention to a remarkable phenomenon that I do not remember to have seen or heard of before, viz. an *annular* spot, which was seen on the 1st of February: it is marked *a* in the diagram of that date, and I have also sketched it on the margin on an enlarged scale: the dark spot was of an irregular pentagonal shape, with a bright speck not quite in the centre. I had a suspicion of a filament uniting it to the side of the *penumbra*, but the power of my instrument (a 3½ feet) was insufficient to verify this. A similar phase has this day appeared in another spot, which will be shewn in the next sheet."

Captain Shea exhibited a book, "containing daily observations of the spots which pass over the sun's disc, taken with a three-foot telescope, by Carey." There are four rows of circles in each page, and the book, if complete, would shew a picture of the disc on every day when the sun is visible. The corresponding days in each year are under each other. Captain Shea says his drawings prove "that spots which disappear on the thirteenth day do *not* reappear on the thirteenth day afterwards, and that they cannot be considered as fixtures."

On the 9th and 10th of last November, Captain Shea "clearly

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\* The circumstance of streams of light crossing solar spots was seen by Mr. Lawson the day of the solar eclipse of May 15, 1836, in a spot whose *umbra* was of the shape of the ace of clubs, only the *penumbra* in this case was not of usual aspect, but resembled flocculent clouds. The streams of light closely resembled coruscations of *aurora borealis*. The *umbra* of this spot was 10080 miles in diameter, and the surrounding shade 32200 miles.

saw large streaks on the sun, having the appearance of water, extending from both eastern and western limbs about one-sixth of his diameter towards the centre, several small spots being distinctly visible on the streaks."

In some additional remarks upon the spots, Captain Shea says, "These spots take thirteen days to pass over the centre of the sun's disc, and although there is a constant succession of them, I have not been able to discover any day, for the last eighteen months, that the same number have appeared a second time as to size or relative position to each other."

A correspondent wishes to know where he can find the most complete account of the solar spots.\*

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*Lunar Eclipse of March 8, 1849.* By Professor Challis, *with the Five-foot Equatoreal, at the Cambridge Observatory.*

"The commencement of the eclipse was estimated to have taken place at  $11^h 25^m 53^s$ , Greenwich Mean Time, and the end at  $14^h 25^m 43^s$ , Greenwich Mean Time. The degree of obscuration of the limb at these two times was judged to be very nearly the same, but whether the shadow was in actual contact with the limb was quite uncertain. It is probable that the mean of the times, viz.  $12^h 55^m 48^s$ , Greenwich Mean Time, may be compared with considerable accuracy with observations made in a similar manner elsewhere.

"The disappearance of  $\delta$  Leonis was observed with great exactness to take place at  $13^h 13^m 17^s.62$ , Greenwich Mean Time. The occultation occurred at the part of the limb which was most obscured by the eclipse, and as the moon's periphery was still very visible, I took particular care to notice whether there was any projection of the star on the moon's disk. The star made a kind of indentation of the limb without apparent diminution of brightness, and disappeared instantaneously, as soon as the periphery passed through the centre of its brightness.

"I noticed a faint, ruddy light spread over the eclipsed portion of the moon's disk, most conspicuous at the parts most remote from the boundary of the shadow. By looking at the moon with a small telescope, magnifying fourteen times, this appearance was rendered very sensible. I have never observed anything similar when the illuminated part of the moon's disk has been visible between new moon and the first quarter. It seems hardly possible to doubt that the origin of this light is the same as that of the redness of the sky at sunrise and sunset."

\* Photographic pictures surely would be attainable with a telescope mounted equatorially, and carried by good clock-work. For researches into the *motion* of the spots, the positions should be determined micrometrically, or an image thrown on a screen might serve, with proper precautions. Reference should be made to the N and S, and to the preceding and following limbs.

By Mr. Hind, at South Villa Observatory.

“ Beginning of the eclipse at  $11^h 25^m 18^s$  mean time. The end was not observed.

“ Nothing unusual was remarked. The shadow had a greenish tinge. About the time of greatest phase it was dark enough to render the eclipsed limb barely traceable with a power of 50 on the eleven-feet refractor.”

Mr. Chalmers, at Weston-super-Mare, observed as follows :—  
“ I saw a star of the sixth magnitude approaching the moon. It travelled along the dark edge, impinging on it, for about  $6^m$  or  $7^m$ . At a quarter past one it was occulted, disappearing entirely. Within two minutes it reappeared, and again travelled along the edge of the moon for about  $2^m$  or  $3^m$ . It was then a second time occulted, and reappeared in about  $10^m$ , when it finally quitted the moon.”

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*On the Longitude of Hobarton, Van Diemen's Land.*

By Commander Shadwell, R.N.

This determination is deduced from meridian transits of the moon observed by Lieut. Kay, R.N., in the years 1843, 4, and 6, while in charge of the Magnetic Observatory there. The instrument employed is an excellent transit by Troughton and Simms, of 30 inches focal length, and  $2\frac{1}{4}$  aperture, mounted on an iron stand. The position is stated to be “ in the garden of the Magnetic Observatory at Rossbank, about a mile outside the town of Hobarton.”\* Commander Shadwell, after a careful examination of the observations, level readings, &c., speaks highly of the correct adjustment of the instrument and the skill of the observer.

There is a large gap in the series, caused by the breaking of the tube of the level, which was sent to England for reparation. One or two spare tubes should always accompany the transit on distant expeditions, and, in case of need, an observer should be ready to supply the place of the level by observations in a mercurial surface.†

In computing Lieut. Kay's observations, Commander Shadwell has used Mr. Riddle's formula, taken from the twelfth volume of the *Memoirs* of the Society, except that he has applied “ the sidereal time of the moon's semidiameter passing the meridian ” to

\* This description is somewhat vague, the site of the transit has probably been connected with some fundamental point, to which the station of Hobarton is referred ; if not, no time should be lost in effecting the connexion.

† Either by an eyepiece, with which he can see the wires reflected, looking downwards, and so adjust ; or by noting the transits of two or three high known stars, as seen in the mercury, which, compared with transits of other known stars, seen *directly*, will give an excellent level error, and with very little trouble.

the time of transit of the bright limb, to get the right ascension of the moon's centre at the time of transit.

In taking the means of the various results, Commander Shadwell has followed Mr. Taylor (Vol. xvi. of the *Memoirs* of the Society), and "assigned to each night's observations a weight proportional to the square root of the number of stars compared with the moon, and multiplied by the motion of the moon in right ascension during one hour of longitude, using the mean of her true motion for the interval between the observations."\*

Treating the observations in this manner, Commander Shadwell finds the following longitude of Lieut. Kay's station, Hobarton, by comparison with the English standard observatories :

	By 1st Limb of Moon.			Obs.		By 2d Limb of Moon.			Obs.
	<sup>h</sup>	<sup>m</sup>	<sup>s</sup>			<sup>h</sup>	<sup>m</sup>	<sup>s</sup>	
Greenwich	9	49	26.03	E.	9	9	49	15.68	E.
Edinburgh			24.12		14			21.72	
Cambridge			31.94		4			20.24	
Oxford ..			25.67		5				
Mean	9	49	26.06		32	Mean	9	49	19.38

Mean of both limbs  $9^h 49^m 22^s.72$  E  $= 147^\circ 20' 40''$  E.

Lieut. Kay finds the latitude of his observatory, by 40 circum-meridian altitudes of the sun  $= 42^\circ 52' 12''.6$  S.

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*Proposal of a Method for Eliminating the Effect of Personal Equation in Computing Longitudes from Transits of the Moon.*  
By Mr. Sheepshanks.

"Many years ago a practical observer threw out the idea of determining longitudes by transits of the sun. He had, as may be imagined, a very imperfect idea of the nature of the problem,† but his mistake suggested to me the following remarks, which may, perhaps, be of use, though in a very different way from that proposed.

"The effect of irradiation is, I think, to be most easily ascertained by observations on *Venus*, in the manner suggested by the Astronomer Royal, and more explicitly pointed out in a paper read at the last Meeting, but besides an error from this cause or from a variation in the apparent diameter due to the imperfection of the telescope, there is undoubtedly a personal equation in *observing a limb* as distinguished from a *star*, and most probably a *different*

\* The proper mode of combining moon-culminating determinations requires considerable care ; there is not, so far as we know, any English solution which can be considered as a fair approximation to the most *probable* result.

† Even now it is not uncommon to hear of young astronomers *observing* lunar transits for determining *minute* differences of longitudes, and *complaining* of the discrepancies they find. Such observations are excellent practice, but *not* available to the object proposed.

personal equation, according as the first or second limb is the object observed. I will not stop to allege various instances where these anomalies seem to have occurred; every transit observer will admit that the phenomena of observing a star, or a limb of the sun or moon, are very different, and most, I think, will acknowledge that they have no feeling of identity of observation between the first and second limb.

"I assume that the observations of the corresponding limbs of the sun and moon are liable to the *same* errors in this respect, and, perhaps, by a little attention to dark glasses, illumination and the effects of irradiation, may be nearly equalised for both bodies; the *aperture* of the object-glass must always be the same in both sets of observations.

"Suppose a large mass of observations of the sun and moon to have been made at two observatories, between which the difference in longitude is required. The lunar transits of the first limb, for instance, give

$$L = \text{the true longitude} + \frac{a-b}{m}$$

where  $a$  and  $b$  are errors of observation at the two places, owing to the *limb* as distinguished from a *star*, and  $m$  is the mean of the moon's motion per second. In like manner the transits of the sun's first limb give

$$L' = \text{the true longitude} + \frac{a-b}{s},$$

where  $s$  is the sun's motion per second, and  $a$  and  $b$  are the same as before, whence

$$L' - L = \frac{a-b}{s} - \frac{a-b}{m},$$

$$\text{or} \quad a-b = m s \frac{L' - L}{m - s}.$$

"The true longitude is

$$L + s \frac{L' - L}{m - s}, \quad \text{or} \quad L' + m \frac{L' - L}{m - s}.$$

"The second limbs must be treated in exactly the same way, and if the two results agree, there will be a strong probability of their truth.

"It is here *supposed* that the observations of the sun are as accurate as those of the moon, which, in standard observatories, is not not far from correct. A traveller should always get the comparative error of himself and of his instrument by previous observations of both limbs of the moon, under a known meridian. This precaution is, it is to be feared, very seldom taken.

"The moon is so regularly observed at Greenwich since the erection of the Altitude and Azimuth instrument, that the best data for calculating the longitude from lunar transits will often be taken from it. It is necessary that the relation between the indications of the Altitude and Azimuth, and the Transit, should first be fully

investigated, so that the error determined by the former instrument may be translated into the error which would have been found by the latter, before the comparisons with the data of the two instruments can be combined; but this may be safely left to the Astronomer Royal, who is already engaged in the subject."

*Elements of several Binary Stars.* By Mr. Hind.

ξ *Böotis*.

"In Vol. VI. of the *Memoirs* of the Royal Astronomical Society, an orbit of this revolving star is given by Sir John Herschel, who founded his elements on all the observations between 1782 and 1833. On comparing this orbit with the angle observed in 1842, I found the computed position less by  $16^\circ$ , and accordingly attempted a correction of the elements. Adopting Sir John Herschel's numbers in the formation of equations of condition, I finally arrived at the following values, which are the best of several sets:—

Perihelion Passage 1780.43.	
Angle of Position at Perihelion .....	$98^\circ 57'$
Node .....	$6^\circ 0'$
Inclination to Plane of Projection .....	$78^\circ 27'$
Excentricity.....	0.7508
Period of Revolution ...	114.8 years.

The differences between the observed and computed angles at certain selected epochs are as subjoined:—

1782.28	comp <sup>d</sup> —obs <sup>d</sup>	=	$-4.5'$
1803.25	"	=	$-0.5'$
1822.40	"	=	$-1.8'$
1829.43	"	=	$-2.9'$
1838.55	"	=	$-1.0'$
1842.30	"	=	$+1.5'$

"At the time of Sir W. Herschel's first observation the position would be changing rapidly, the star being near its perihelion passage. I think the excentricity is the most uncertain element.

Σ 1938 near μ *Böotis*.

"Two orbits previously calculated by me for this close binary star have already appeared in the *Monthly Notices* of the Society. The Rev. W. R. Dawes having favoured me with several sets of measures taken with his large equatoreal at Cranbrook in 1847 and 1848, I have recomputed the orbit, these later observations being of high importance in the investigation.

"My third elements of  $\Sigma$  1938 are:—

Perihelion Passage 1851.75	
Projected Perihelion .....	219° 0'
Node .....	104 50
Inclination .....	58 2
Angle between $\pi$ and $\zeta$ on the orbit	103 22
Excentricity .....	0.8775
Semi-major axis .....	3".08
Period of Revolution .....	458.65 years.

The maximum distance in the apparent orbit is 3".35 at an angle of about 50°, and the least distance 0".19 in the direction of about 200°. It is probable that the star will become single with the best telescopes in the ensuing year; the present is, therefore, an epoch of much interest, and it is to be hoped observers will not forget this object during the spring and summer.

*70 Ophiuchi.*

"I have paid close attention to the elements of this remarkable binary star, which has been signalised by Professor Mädler as exhibiting a deviation from the Newtonian law of gravitation. After repeated attempts, I arrived at the following orbit:—

Perihelion Passage 1807.48	
Node .....	122° 14'
Angle between $\pi$ and $\zeta$ on the orbit	168 6
Inclination ..	47 20
Excentricity .....	0.4973
Period .....	88.48 years.

These numbers represent the observations tolerably well throughout, but there is still a tendency to give the angle too small between 1840 and the present time, which appears peculiar to most orbits that have yet been published.

"By Encke's method, explained in the *Berliner Jahrbuch* for 1832, I found the excentricity 0.505, and the period of revolution 86<sup>m</sup>.77; the results, however, are not so satisfactory as those given above.

*$\tau$  Ophiuchi.*

"I think the orbit of this interesting star will prove something like the following:—

Perihelion Passage 1824.8	
Projected Perihelion .....	106° 0'
Node .....	130
Inclination .....	48 30
Excentricity .....	0.575
Period .....	104 years.

These elements are altogether different from those published by Professor Mädler in his *Untersuchungen über die Fixtern-Systeme*, which assign an orbit deviating but slightly from a circle.

λ *Ophiuchi*.

“The elements subjoined are perfectly satisfactory. They were calculated from all the observations known to me at the close of the year 1848. The angle given by Sir W. Herschel in 1802 is altered 180°, as the only way of reconciling the whole series of positions with any supposable orbit.

Perihelion Passage 1791·214	
Position at Perihelion .....	177° 50'
Ascending Node .....	30 23
Inclination.....	49 40
Angle between $\pi$ and $\Omega$ on orbit ...	135 24
Excentricity .....	0·4772
Semi-axis major .....	0"·847
Period .....	95·88 years.

In this orbit the least apparent distance = 0"·31 at an angle of about 125° and the greatest apparent distance = 1"·11 at an angle of 10°. The comparison with observations shews that the errors are small considering the great difficulty attending measures of this star."

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*Remarks on Irradiation.* By Capt. Shortrede.

With reference to the subject of irradiation brought before the Society at last meeting, Capt. Shortrede states the following facts which he observed in Western India:—

“The island of Karanja, in Bombay Harbour, was one of my stations, the summit being about 1000 feet above the sea. The top of the pillar under the dome of the Observatory at Bombay is about 70 feet above the sea, and distant from Karanja about eight miles. To observe the centre of the pillar, I had the slit of the dome turned towards Karanja, and a heliostat being outside, the sun's light was thrown upon a screen having a circular hole, five-eighths of an inch in diameter, carefully adjusted over the centre of the pillar. Viewed from Karanja, the appearance of this was a beautiful planetary disc, perfectly round, the edges being *nicely* in contact with the sides of the slit on the dome. This appearance continued unvaried for several days, and there was no sensible difference by varying the aperture of the telescope from two inches to half an inch. The slit in the dome is fifteen inches wide, and the sun's light passing through a hole of five-eighths of an inch, seemed of exactly the same size. The object *appeared* equally bright throughout, and the edges were sharp and well defined.

"The telescope was one of Dollond's master-pieces; it had a triple object-glass of two inches clear aperture, and bore well powers of 40 and upwards; but for terrestrial objects I preferred a power of 25.

"Another fact of the same kind, but not admitting of such definite measurement, was that at Mandwi station. I had a referring mark on Bhatras, distant about seven miles, both being peaks at a mean height of about 4000 feet above the sea, and about 2000 feet above the intervening ground. The sun's light was transmitted through a hole three-tenths of an inch in diameter, and in strong daylight (with the telescope as well as with the naked eye) it had much the same appearance as *Sirius* by night. It had not the round planetary disc observed in the other case. The wires in the focus of the telescope subtended rather more than 3", and at their intersection they subtended between 3".5 and 4"; but I found that I could not get them entirely to hide the referring mark.\*

"In each of these cases the apparent enlargement of the object may possibly have been chiefly owing to the light reflected from the particles of air very near the path of the ray. They are quite distinct from the enormous enlargements to be seen when the rays pass near the surface of the earth through an atmosphere of varying density, for in such cases the objects are always unsteady and flaring.

"I may mention also in reference to the visibility of small opaque objects on a bright ground, that on one occasion, from a station twenty-five miles or more to the eastward, I observed the Pangaon station at sunset, when the station-pole, being *projected on the sun's disc*, was a remarkably good object. For several days I had found it invisible otherwise. The pole was about twenty inches thick and about fifteen feet high. It did not occur to me that the breadth was sensibly diminished."

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*On the Manufacture of Optical Glass in England.*

By Mr. Simms.

"The difficulty that has hitherto attended the construction of achromatic telescopes of large apertures in this country has arisen, as is well known, from the faulty state of our flint-glass manufacture, and notwithstanding the efforts that have from time to time been made with the view to its improvement, it has till lately continued so defective in all the qualities requisite for forming a good telescope, that I recollect to have succeeded in only two instances in my attempts to make with it unexceptionable object-glasses of only three and a-half inches aperture.

"Our supplies of flint-glass have, therefore, been drawn from the Continent, and although discs of great purity have been obtained

\* 0.3 inch subtends 1" at the distance of a mile, nearly.

of diameters varying from four to nine inches, yet the first cost of the disc from the foreign manufacturer, and the subsequent risk of its not turning out well after the expenditure of great labour upon it, required necessarily so great a price to be set upon the finished article (to make it at all remunerative), that opticians, on the one hand, have been deterred from engaging in such costly and hazardous undertakings (which generally ended in loss), and astronomers, on the other, however ardent admirers of the science, have been prevented from engaging successfully in the pursuit.

"It will be gratifying to the members of the Society, and to the lovers of astronomy generally in this country, to learn that such a state of things no longer continues. After much labour, and no doubt at considerable cost, the firm of Chance and Co. of Birmingham, with the assistance of a foreign artist, have succeeded in manufacturing flint-glass for optical purposes by no means inferior, so far as my trials enable me to judge, to the very best that was formerly prepared by the elder Guinand. Besides several of smaller dimensions, I have made of this material, together with the crown-glass of the same firm, which has long been of excellent quality, one object-glass of six inches diameter, with which perhaps I have had as little trouble as the nature of such a work will admit of. I am about to make trial of a glass of much larger aperture than the one above mentioned, and the result of this experiment, of the successful issue of which I have no doubt, shall in due time be communicated to the Society."

Professor Potter, of University College, London, wishes to call attention to a communication published by him in *Brewster's Journal*, New Series, vol. iv. p. 18, from which it appears that the Professor used the *chilling* process in casting specula on an old steel mirror, and with perfect success, so far back as 1831.

Captain Shortrede presented a "perpetual calendar, giving the days of the week for all time." This consists of three small concentric circles of card, from which, when set according to the instructions, the day of the week corresponding to any yearly and monthly date whatever may be taken by inspection.

Sir Andrew Lang, Governor of St. Croix, mentions the occurrence of an aurora borealis at St. Croix,  $17^{\circ} 44' 32''$  north latitude, and  $64^{\circ} 41'$  west longitude. "The red lurid glare ascended high above the hills" and led several persons to believe that a tremendous fire had occurred on the islands of St. Thomas and St. John's, which are forty miles distant. This aurora was seen on the 17th of November, 1848, and it appears that an aurora of extraordinary brilliancy was seen on the same night over the north of the British islands, and also at Montreal. Sir Andrew Lang has been a resident in the West Indies for fifty-four years, and paid attention to meteorology for more than thirty years, but this is the first aurora which he has witnessed.

Mr. Lowe remarks with respect to Dr. Forster's communication (see *Monthly Notice* for January last, p. 37), that "from the 1st January, 1817, to the 31st December, 1848, the new moon has fallen 55 times on a Saturday, and that, consequently, the number of rainy days which ensued should be, according to Dr. Forster, about 1100."\* On consulting the register of his friend Mr. Tatem, of Reading, Mr. Lowe finds "that rain occurred on 605 days. The number of fair days exceeded the number of rainy days 36 times out of the 55, and once no rain fell for 20 days."

In 7 cases rain did not fall on more than 5 days

29	"	"	10	"
10	"	"	19	"

In 8 cases observed at Greenwich, Mr. Lowe finds that once there were 4 days of rain, once 5 days, thrice 9 days, once 11 days, once 12 days, and once 17 days of rain.\*

M. Fasel sent an elaborate drawing of the parhelia observed at Stone, March 29, 1848, and a meteorological register for 1848.

Professor Schumacher has had the kindness to forward the following elements of Goujon's comet, calculated by Professor Argelander:—

Perihelion Passage, 1849, May 26.5572, Berlin Mean Time.

$\pi$	.....	235	45	20
$\delta$	.....	202	33	15
$i$	.....	67	9	34
Log $q$	.....	0.06413	Motion direct.	

\* Mr. Lowe has said that the number of rainy days, according to Dr. Forster, should have been 1500, but Dr. Forster's statement relates to the next 20 days after the new moon; the number of rainy days is  $20 \times 55 = 1100$ . The only way in which this matter touches astronomy (and, therefore, concerns the Society), is, that if an empirical rule connecting the weather with the *phases* of the moon, and with *certain* days of the week, were *established*, it might be the business of astronomers to give an astronomical form to the cycle, which again might lead to a physical explanation. Until the *fact* is agreed upon, the question is purely *meteorological*, and, as such, does not belong to us.

#### ERRATA.

p. 95, for Stowe, read Stone.

97, March 1st, Comp<sup>d</sup>—Obs<sup>d</sup> R.A., for  $-1^{\text{h}}45$ , read  $-1^{\text{h}}37$ .

103, Emersion of Jupiter's 4th Satellite, for  $11^{\text{h}}$ , read  $14^{\text{h}}$ .



## ROYAL ASTRONOMICAL SOCIETY.

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G. B. AIRY, Esq., Astronomer Royal, President, in the Chair.

The Right Hon. the Lord Chief Baron;  
John Fletcher Miller, Esq., Whitehaven;  
Isaac Fletcher, Esq., Tarn Bank, near Cockermouth;  
Lieut. Robt. Wm. Hall Hardy, R.N., Kilkenny House, Bath;  
John Bennett, Esq., 65 Cheapside;

were balloted for and duly elected Fellows of the Society.

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*Letter from Professor Bond, Director of the Cambridge, U. S.,  
Observatory, to the Secretary.*

"It is purposed in behalf of the Coast Survey of the United States to attempt the determination of the difference of longitude between the Royal Observatory at Greenwich and the observatory at Cambridge, in the United States, by means of chronometers, transported by railroad from Greenwich to Liverpool, and from thence by the mail steamers to Boston.

"Professor Bache, the superintendent of the United States Coast Survey, has requested me to make the requisite arrangements for carrying this project into execution.

"It is intended to employ constantly during the season between thirty and forty select chronometers. There will be three principal stations, namely, Greenwich, Liverpool, and Cambridge; or, if Greenwich were connected with Liverpool by the magnetic telegraph, the stations, so far as the transmission of chronometers was concerned, might be reduced to Liverpool and Cambridge, and we are assured of the valuable co-operation of Mr. Hartnup, the director of the Liverpool Observatory.

"It being desirable that there should be uniformity of action in carrying on this work, Professor Bache has caused blank forms to be drawn up and printed for the use of the observers, and it is proposed that my son, R. F. Bond, who now visits England to select chronometers and make preliminary arrangements, should practise with those observers who would be likely to be engaged in this enterprise, in order to determine, as he has done with us, the amount of personal equation.

"The advice and assistance of the Astronomical Society of London would be valuable to us in regard to the transmission of the chronometers by the Royal Mail steamers. If you think that the project is worthy of its consideration, I shall be greatly obliged by your presenting the subject at the next meeting of that body."

## DE GASPARIS' PLANET.

"Signor De Gasparis, of the Observatory of Naples, discovered a planet about 9.10 mag. on the 12th April last, while comparing Steinheil's Map (Hora xii.) with the heavens. Unfavourable weather prevented any exact determination that night, but on the 14th and 17th comparisons were made through other stars with No. 23098 of the *Histoire Céleste*,\* which gave the results following:—

	Naples M. T.	R. A.	N.P.D.
1840.	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
April 14	9 2 53	* — 0 30	* + 10 52
17	14 2 42	* — 2 59	* — 4 16

"The planet is retrograding and approaching the equator."—  
From Professor Schumacher's Circular.

*Extract of a Letter from Professor Schumacher to the  
Astronomer Royal.*

The following observations of Gasparis' Planet have been made at Berlin, Altona, Hamburg, and South Villa. The comparisons are with the places deduced from Encke's elements. The Mean Times are those of Berlin, Altona, Hamburg, and Greenwich, and are distinguished by the initial letter.

		M. T.		R. A.		N.P.D.		Correction to Elements.	
1840.		<sup>h</sup> <sup>m</sup> <sup>s</sup>		<sup>°</sup> <sup>'</sup> <sup>''</sup>		<sup>°</sup> <sup>'</sup> <sup>''</sup>		<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
May 13	Prof. Encke	12 19 2.2	B	180 18 37.1		95 43 55.9			
15	"	11 29 26.3	B	17 44.8		40 21.0			
17	Dr. Petersen	10 40 33.5	A	180 18 2.0		95 37 30.8	— 9.5	+ 14.0	
	M. Sonntag	12 15 44	A	17 52.9		37 16.3	20.8		5.0
	M. Rümker	10 23 13.2	H	18 6.2		37 22.3			
18	Dr. Petersen	10 0 23.7	A	180 18 41.4		95 36 6.9	— 14.7	+ 9.1	
	"	18 40.4	A	18 40.5		35 55.7	14.5	— 1.2	
	M. Sonntag	25 46.0	A	18 38.7		35 59.6	16.2	+ 3.3	
	M. Rümker	10 21 14.2	H	18 37.7		36 2.5			
20	Dr. Petersen†	10 0 25.2	A	180 21 8.0		95 33 40.4	— 12.1	+ 2.0	
	"	31 29.3	A	21 2.1		33 47.6	20.1		10.3
	M. Sonntag	10 38 29	A	20 59.3		33 39.5	23.2		2.7
	M. Querling	11 36 7	A	21 4.6		33 38.0	— 25.0	+ 3.6	
	M. Rümker	10 19 22.0	H	21 0.1		33 36.8			
21	M. Sonntag	10 40 48	A	180 22 47.2		95 32 47.9			
	M. Rümker	10 16 48.7	H	22 37.5		32 44.5			
22	"	10 28 35.5	H	24 35.5		32 4.4			
27	Mr. Hind‡	9 51 45	G	180 39 40.5		95 29 50.4			

* Epoch	Mag.	R. A.	An. Prec.	N.P.D.	An. Prec.
1800.		<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
Virgo	8½	12 9 48.64	+ 3.077	97 0 48.4	+ 20.04

† The planet faint in this comparison.

‡ Mr. Hind thought the planet rather fainter than 10 mag.

*Elements.*

Professor Schumacher has had the goodness to forward to the President, Professor Encke's elements of the newly-discovered planet. These elements are deduced from the observations of April 14, May 13 and 15, without taking Aberration, Nutation, Precession, Parallax into account.

Epoch 1849, May 13<sup>5</sup>. Berlin M.T.

Mean longitude	211° 8' 31 <sup>1</sup>	
Anomaly	328° 5' 1 <sup>3</sup>	
Perihelion	243° 3' 29 <sup>8</sup>	
Node	286° 34' 31 <sup>1</sup>	
Inclination	3° 46' 5 <sup>9</sup>	
$\phi$	9° 50' 36 <sup>8</sup>	$e$ 0,170959
Log. $a$	0.514044	Mean daily motion 601'' <sup>09</sup>

The Computed—Observed places are as follows :—

	$\Delta \alpha$	$\Delta \delta$	
April 14	— 0 <sup>2</sup>	0 <sup>0</sup>	
17	—7 37 <sup>5</sup>	—11 <sup>8</sup>	error of 30 <sup>s</sup> in the observation.
May 13	0 <sup>0</sup>	— 0 <sup>1</sup>	
15	— 0 <sup>6</sup>	+ 0 <sup>3</sup>	
16	— 4 <sup>9</sup>	+ 3 <sup>2</sup>	

*Ephemeris from Encke's Elements.* By Mr. Graham.\*

For Greenwich Mean Midnight.

1849.	R.A.	N.P.D.	Hor. Par.	1849.	R.A.	N.P.D.	Hor. Par.
lay 25	h m s	° ' "	"	June 14	h m s	° ' "	"
26	12 2 13	95 30 <sup>2</sup>	3 <sup>92</sup>	15	12 10 42	95 51 <sup>2</sup>	
27	2 28	29 <sup>9</sup>		16	11 20	53 <sup>6</sup>	3 <sup>54</sup>
28	2 43	29 <sup>9</sup>		17	11 58	56 <sup>1</sup>	
29	2 59	30 <sup>0</sup>	3 <sup>86</sup>	18	12 38	95 58 <sup>7</sup>	
30	3 7	30 <sup>2</sup>		19	13 19	96 1 <sup>5</sup>	3 <sup>49</sup>
31	3 36	30 <sup>5</sup>		20	14 0	4 <sup>4</sup>	
une 1	3 56	31 <sup>0</sup>	3 <sup>81</sup>	21	14 42	7 <sup>4</sup>	
2	4 17	31 <sup>6</sup>		22	15 26	10 <sup>4</sup>	3 <sup>44</sup>
3	4 40	32 <sup>3</sup>		23	16 11	13 <sup>7</sup>	
4	5 4	33 <sup>1</sup>	3 <sup>75</sup>	24	16 56	17 <sup>0</sup>	
5	5 29	34 <sup>1</sup>		25	17 42	20 <sup>4</sup>	3 <sup>39</sup>
6	5 55	35 <sup>3</sup>		26	18 29	24 <sup>0</sup>	
7	6 22	36 <sup>6</sup>	3 <sup>69</sup>	27	19 17	27 <sup>7</sup>	
8	6 51	37 <sup>9</sup>		28	20 7	31 <sup>4</sup>	3 <sup>34</sup>
9	7 21	39 <sup>4</sup>		29	20 57	35 <sup>3</sup>	
10	7 51	41 <sup>1</sup>	3 <sup>64</sup>	30	21 48	39 <sup>3</sup>	
11	8 23	42 <sup>8</sup>		July 1	22 40	43 <sup>3</sup>	3 <sup>30</sup>
12	8 56	44 <sup>7</sup>		2	23 33	47 <sup>5</sup>	
13	9 31	46 <sup>7</sup>	3 <sup>59</sup>	3	24 26	51 <sup>7</sup>	
	12 10 6	95 48 <sup>9</sup>			12 25 20	96 56 <sup>1</sup>	3 <sup>25</sup>

\* An ephemeris for every 4 days has been communicated by Mr. Breen of the Royal Observatory.

## METIS.

Ephemeris.\* By Mr. Graham.

For Greenwich Mean Midnight.

1849.	R.A.			N.P.D.			1849.	R.A.			N.P.D.		
	h	m	s	°	'	"		h	m	s	°	'	"
May 3	21	55	47.51	107	24	25.9	May 19	22	14	26.04	106	23	48.1
4		57	2.75	20	9.9		20		15	29.36	20	39.1	
5		58	17.34	15	57.1		21		16	31.82	17	35.4	
6	21	59	31.25	11	47.6		22		17	33.42	14	37.2	
7	22	0	44.48	7	41.6		23		18	34.14	11	44.6	
8		1	57.03	107	3	39.2	24		19	33.96	8	57.6	
9		3	8.87	106	59	40.5	25		20	32.88	6	16.4	
10		4	19.99	55	45.8		26		21	30.89	3	41.1	
11		5	30.39	51	55.0		27		22	27.96	106	1	11.8
12		6	40.05	48	8.4		28		23	24.10	105	58	48.7
13		7	48.97	44	26.0		29		24	19.28	56	31.8	
14		8	57.13	40	48.0		30		25	13.49	54	21.3	
15		10	4.51	37	14.5		31		26	6.72	52	17.3	
16		11	11.11	33	45.7		June 1		26	58.96	50	20.0	
17		12	16.90	30	21.5		2	22	27	50.20	105	48	19.3
18	22	13	21.89	106	27	2.3							

## Horizontal Parallax.

May 3	3.36	May 15	3.60	May 27	3.86
7	3.43	19	3.68	31	3.96
11	3.51	23	3.77	June 3	4.07
Log. Δ					
May 3	0.40649	May 15	0.37759	May 27	0.34643
7	39713	19	36744	31	0.33562
11	0.38748	23	0.35705		

Continuation of the Ephemeris of Metis. By Mr. Graham.

For Greenwich Mean Midnight.

1849.	R.A.			N.P.D.			1849.	R.A.			N.P.D.		
	h	m	s	°	'	"		h	m	s	°	'	"
June 3	22	28	40.40	105	46	45.7	June 13	22	36	2.87	105	36	13.9
4		29	29.59	45	8.9		14		36	40.74	35	54.2	
5		30	17.73	43	39.3		15		37	17.37	35	42.9	
6		31	4.79	42	16.9		16		37	52.74	35	40.1	
7		31	50.77	41	1.8		17		38	26.84	35	46.0	
8		32	35.65	39	54.3		18		38	59.64	36	0.6	
9		33	19.41	38	54.4		19		39	31.13	36	24.1	
10		34	2.03	38	2.3		20		40	1.28	36	56.5	
11		34	43.49	37	18.1		21		40	30.08	37	38.0	
12	22	35	23.78	105	36	42.0	22	22	40	57.51	105	38	28.5

\* An Ephemeris of Metis by Dr. Gould was communicated by Professor Schumacher.

1849.	R.A.			N.P.D.			1849.	R.A.			N.P.D.		
	h	m	s	°	'	"		h	m	s	°	'	"
June 23	22	41	23.55	105	39	28.3	July 3	22	44	24.40	105	57	59.7
24		41	48.20		40	37.2	4		44	34.18	106	0	43.1
25		42	11.43		41	55.4	5		44	42.39		3	35.9
26		42	33.22		43	22.9	6		44	49.01		6	38.3
27		42	53.57		44	59.7	7		44	54.03		9	50.2
28		43	12.45		46	46.0	8		44	57.43		13	11.5
29		43	29.86		48	41.8	9		44	59.19		16	42.5
30		43	45.77		50	47.0	10		44	59.31		20	22.9
July 1		44	0.17		53	1.8	11		44	57.77		24	12.7
2	22	44	13.06	105	55	26.0	12	22	44	54.56	106	28	11.8

Horizontal Parallax.

June 2	4.01	June 18	4.45	July 4	4.94
6	4.11	22	4.57	8	5.07
10	4.22	26	4.69	12	5.20
14	4.33	30	4.81		

"The *continuation* is from the same elements as the first portion. I have since computed fresh elements, which agree better with the observations; these are subjoined.

Epoch, May 0.0, Greenwich M.T.

Mean Anomaly	.....	144	9	44.3	} Mean Eq. May 0.0.
$\pi$	.....	71	8	46.8	
$\Omega$	.....	68	27	46.8	
$i$	.....	5	35	47.1	
$\phi$	.....	7	4	0.5	
Log $a$	.....			0.3776655	
$\mu$	.....			962".7384	

The corrections to the ephemeris, according to these elements, are

	R.A.	N.P.D.
1849. May 1.0	-15.12	+1 26.6
July 20.0	-30.85	+3 18.2

HEBE.

LIVERPOOL.

Equatoreal.

(Mr. Hartnup.)

1849.	Greenwich M.T.			R.A.			N.P.D.			Comp <sup>d</sup> —Obs <sup>d</sup> .		Star.
	h	m	s	h	m	s	°	'	"	R.A.	N.P.D.	
April 26	9	13	47.3	6	53	50.63	70	29	53.2	+6.27	-15.8	2233-2330
28	8	57	42.1	6	56	54.93	70	25	46.6	+6.56	-11.7	2271-2350

"Corrected for refraction and parallax, and compared with M. Luther's ephemeris, published in the *Monthly Notices*, Vol. ix. No. 6."

*Observations of the Elongations of the Satellites of Saturn, made during the Opposition of 1848 with the 20-foot Equatoreal.*  
By Mr. Lassell.

"The powers generally used were 219, 297, and 366. The elongations were measured in arc of right ascension, and not in the

direction of the major axis of *Saturn's* ring. This was done for greater accuracy as well as convenience. In the earlier observations, most of the distances are deduced from differences of transits of *Saturn's* limb and the satellite, reduced to *Saturn's* centre by applying the semi-diameter from the *Nautical Almanac*; but the later measures were chiefly micrometrical—a method I greatly prefer and now constantly employ,—except in the great elongations of *Iapetus*, which are too distant for the micrometer. Owing to the present position of *Saturn's* ring, the nearer satellites did not wander sensibly from the plane of the ring; when the more distant ones were obviously out of that plane, I took differences of declination of the satellites and *Saturn's* limb, reduced to his centre.

“The sign + affixed to any measured elongation indicates that the satellite is ascertained, or believed to be receding from the planet; and the sign —, that it is approaching.

### Mimas.

1848. d		
Sep. 16.42	Estimated to be at its greatest eastern elongation from <i>Saturn's</i> limb, about 1 diameter of the planet.	
19.46	Estimated to be 10'' distant from the preceding limb, moving away from the planet.	
21.54	Estimated to be 30° short of its greatest elongation westward.	

### Enceladus.

1848. d		
Sep. 16.45	36'' E.	estimated
18.37	34 W.	„
Oct. 17.34	28 + W.	„
25.46	36 W.	„
29.43	28 W.	„
Nov. 14.38	40 E.	„

### Tethys.

Oct. 22.45	28.7 + E.	4 obs.
25.46	43.9 + W.	3 „
29.43	38 W.	estim.
Nov. 4.35	20 — W.	„
14.38	49 E.	3 obs.

### Hyperion.

Sep. 21.55	234'' E.
22.41	207 E.
Oct. 20.35	178 W.
22.44	203 W.
Nov. 14.36	133 W.
24.45	202.8 E.

### Dione.

1848. d		
Oct. 5.46	48'' E.	
16.50	41 E.	3 obs.
17.34	26 E.	3 „
22.45	55 — E.	4 „
25.46	39.6 — E.	4 „
29.43	44.5 — W.	3 „
Nov. 9.28	55.4 — W.	4 „
14.38	50 + W.	2 „
24.45	44.7 — E.	2 „

### Rhea.

Oct. 5.46	66'' W.	
16.50	80 E.	
17.34	5 — E.	
18.35	74 + W.	5 obs.
20.34	64 + E.	4 „
21.45	56 — E.	5 „
22.45	49 + W.	6 „
29.43	66.9 + E.	3 „
Nov. 4.35	26 — E.	estim.
11.26	15 + E.	„
14.38	69 + W.	6 obs.
21.35	77 + E.	3 „
24.45	37.2 — W.	2 „

*Titan.*

1848.	d				
Sep.	21'54	193	E.		
Oct.	5'46	183	E.	2 obs.	
	16'50	127	—W.	3	"
	17'34	76	—W.	3	"
	18'35	occulted by <i>Saturn</i> .			
	20'34	134	E.	3	"
	21'45	181	E.	4	"
	22'45	197	E.	2	"
	29'43	166'5	+ W.	3	"
Nov.	4'35	75'5	+ E.	3	"
	9'28	148	—E.	4	"
	11'26	91'6	—E.	3	"
	14'38	163	+ W.	4	"
	21'35	134	+ E.	4	"
	24'45	173'4	—E.	2	"
	30'36	159'8	+ W.	2	"
Dec.	1'43	171'7	—W.	1	"
				14'4 S.	2 obs.
				13'5 S.	2 "
				12'6 N.	1 "
				6'1 S.	1 "
				11'9 N.	2 "

*Iapetus.*

Sep.	21'56	439'5	E.		
	22'41	482	E.		
Oct.	5'46	513	E.	110	N. of <i>Saturn</i> 's centre.
	16'50	127	E.	89	N. 2 obs.
	17'34	86	E.		
	18'35	38	E.	62	N. 3 "
	20'34	43	W.		
	21'45	88	W.	52	N.
	22'45	134	W.	45	N.
	25'46	250	W.	40	N.
	29'43	388'3	W.	5	N.
Nov.	4'49	524	W.	30	S.
	9'28	538'6	W.	61	S. 2 "
	11'26	534	W.	64'3	S. 3 "
	14'38	475	W.	76	S. 2 "
	21'35	266	W.	73'8	S. 3 "
	24'45	146'6	W.	68'8	S. 2 "
	30'40	104'2	E.	44	S. 1 " ?
Dec.	1'43	149	E.		

*Note on the Mass of Uranus.* By Mr. Adams.

"The mass of *Uranus* is a very important element in the determination of the orbit of *Neptune*. Two values of this mass have been given, differing widely from each other. Bouvard, from the action of *Uranus* on *Saturn*, found the mass to be  $\frac{1}{17918}$ , that of the sun being = 1; while more recently, from observations of the satellites, Lamont has obtained the value  $\frac{1}{24605}$ . In order to throw light on this subject, Mr. Lassell was kind enough to make for me the observations of the satellites of *Uranus*, which are given in the *Monthly Notice* for March last.

"These I have carefully reduced, and the value of the mass which I have found from the observations of the fourth satellite (which are more to be depended on for this purpose than those of the second) is  $\frac{1}{20897}$ , which is almost exactly a mean between the results of Bouvard and Lamont. In obtaining this result, I have rejected the first day's observations, which are discordant both for the second and fourth satellites.

"I have also reduced all Sir Wm. Herschel's measures of distance of the satellites given in his paper in the *Phil. Trans.*, 1815, and the value of the mass obtained from the observations of the fourth satellite is  $\frac{1}{21183}$ , which agrees very closely with that found from Mr. Lassell's observations. Although, therefore, more numerous observations will be requisite in order to obtain a mass which may be used with confidence in the theory of *Neptune*, I have no doubt that the value  $\frac{1}{21000}$  is much nearer the truth than either of those which have been previously given, and I shall accordingly employ it in my subsequent calculations respecting the orbit of *Neptune*.

"The most probable values of the periods of the second and fourth satellites, given by the combination of the observations of Sir Wm. Herschel, Sir J. Herschel, Lamont, and Mr. Lassell, are  $8^d.7058435$  and  $13^d.463139$  respectively; but the remaining errors of the epochs are greater than can with probability be ascribed to mere errors of observation, and seem to indicate the existence of considerable perturbations."

### GOUJON'S COMET.

#### BERLIN.

(Dr. Galle.)

1849.	Berlin M.T. h m s	R.A. ° ' "	Dec. ° ' "
April 26	10 20 21	165 30 59.4	+ 10 40 49.8
27	10 6 37	165 28 39.2	+ 13 51 12.3

#### HAMBURG.

(M. G. Rümker.)

	Hamburg M.T. h m s	R.A. ° ' "	Dec. ° ' "
April 23	9 27 27.6	165 45 26.6	+ 0 28 30.6
24	8 51 41.8	39 30.3	Meridian.
May 2	10 36 1.0	30 34.1	28 4 35.8
3	10 31 54.1	33 57.3	30 29 5.9
4	10 23 53.2	38 8.8	32 44 44.7
5	10 3 3.3	43 14.9	34 51 37.5
	11 3 37.3	43 29.8	34 56 51.6
6	9 25 55.9	165 49 1.0	36 49 53.6
12	11 43 33.4	166 42 38.2	46 46 30.6
18	11 58 27	168 3 8.0	53 35 0.4
20	11 41 58.6	35 54.3	55 22 2.8
21	11 7 1.3	168 52 55.4	56 10 20.0
22	11 59 18.3	169 11 11.2	+ 56 59 24.7

LIVERPOOL.			Equatoreal.			(Mr. Hartnup.)		
	Greenwich M.T.			R.A.	Log. $\frac{p}{P}$	N.P.D.	Log. $\frac{q}{P}$	Star.
1849.	h	m	s	h	m	s		
April 23	11	59	36.4	11	2	56.69 + 8.4320	89 3 47.1—9.9028	a
26	10	55	13.0	11	2	4.00 8.3043	79 7 11.1 9.8371	b
27	12	31	34.1	11	1	53.07 8.5276	75 42 50.9 9.8390	c
28	12	27	3.6	11	1	47.37 8.5336	72 38 45.4 9.8200	d
30	12	29	18.1	11	1	47.99 8.5625	66 52 28.8 9.7850	e
May 7	10	35	29.6	11	3	44.81 8.4667	51 7 48.3 9.5008	f
8	11	47	53.8	11	4	16.72 8.6303	49 15 51.2 9.5781	f
11	13	58	22.5	11	6	11.95 + 8.7542	44 26 12.2—9.7442	g
	a	B.A.C. 3903, 3909					d B.A.C. 3838	
	b	,, 3761, 3837					e ,, 3834	
	c	,, 3483					f ,, 3856	
							g ,, 3868	

"The observations are corrected for refraction. The corrections to be applied for parallax in time and arc are represented by  $p$  and  $q$ .  $P$  is the equatoreal horizontal parallax.

"The light of the comet was strongly condensed towards the centre; but the nucleus was not so well defined, nor the coma so extensive, as in the Schweizer-Bond Comet. I did not observe any tail."

#### Elements.

M. d'Arrest has calculated elements on the following observations:—

	h	m	s	Paris.	R.A.	Dec.
April 15	11	39	6	Paris.	167 7 0.0	—25 31 25.0
20	11	19	13	Altona.	166 7 57.6	—9 36 31.2
27	9	41	23	Leipsic.	165 28 29.0	+13 48 20.2

T. 1849, May 26.43349, Berlin M.T.

$\pi$  .... 235 31 25.3 } Mean Eq.

$\delta$  .... 202 30 55.0 } 1849.0

$i$  ..... 67 19 59.7

Log.  $q$  0.0648988 Motion direct.

"These elements represent Dr. Petersen's observations, very nearly."—  
Professor Schumacher.

#### Ephemeris. By M. Weyer.

For Berlin Mean Midnight.

	R.A.	Dec.	Log. $\Delta$		R.A.	Dec.	Log. $\Delta$
	°	'			°	'	
April 30	165	29	+23 6	9.590	May 9	166 15	+42 32
May 1	30	25	48		10	24	44 6
2	32	28	21		11	34	45 35
3	36	30	46		12	45	46 59
4	41	33	2	9.635	13	166 56	48 17
5	47	35	10		14	167 8	49 31
6	165 53	37	11		15	21	50 41
7	166 0	39	5		16	167 35	+51 46
8	166 7	+40	52	9.685			9.782

From M. G. Rümker's elements, which agree pretty nearly with those of Professor Argelander.

*Ephemeris of Goujon's Comet.* By M. Weyer, from his own elements, which represent the Hamburg observations of May 12 thus,—

		$\Delta \kappa \cos. \delta$		$\Delta \delta$	
Calcul.—Obs. =		+ 4'.8		+ 5'.0	
<i>Ephemeris (for 10<sup>h</sup> Berlin M.T.)</i>					
	R.A.	N.P.D.	log. $\Delta$	log. $r$	Light
1840.	°	°			
May 20	168 34.7	34 42.4	.98269	.0658	.428
21	168 52.0	33 52.8	.8372	.0653	.409
22	169 10.0	33 5.7	.8473	.0650	.391
23	28.5	32 20.7	.8571	.0646	.374
24	169 47.9	31 37.9	.8668	.0644	.358
25	170 8.0	30 57.3	.8761	.0643	.343
26	28.8	30 18.5	.8853	.0643	.329
27	170 50.3	29 41.4	.8941	.0643	.316
28	171 12.5	29 6.0	.9029	.0644	.303
29	35.4	28 32.4	.9113	.0646	.291
30	171 58.9	28 0.3	.9197	.0649	.280
31	172 23.1	27 29.5	.9277	.0652	.270
June 1	172 48.0	27 0.0	.9356	.0657	.260
2	173 13.5	26 31.9	.9432	.0662	.250
3	173 39.7	26 5.0	.9507	.0668	.241
6	175 2.7	24 50.2	.9720	.0691	.216
9	176 32.2	23 44.1	.9918	.0721	.0194

"The intensity of light ( $= \frac{1}{\Delta^2 r^2}$ ) supposes, as unity, the intensity at its discovery.  $\Delta$  and  $r$  are, as usual, the distances of the comet from the earth and sun."—*Communicated by Professor Schumacher.*

### SCHWEIZER'S COMET.\*

This comet was discovered on April 11th, at 9<sup>1</sup>/<sub>2</sub> P.M., by Professor Schweizer, of Moscow, who saw it in conjunction with  $\chi$  Boötis, and about 1° south of the star.

Professor Bond observed the comet a few hours later (see p. 128). It was discovered by Mr. Graham on the 14th. The comet had a strong, star-like, central condensation, an extensive coma, and no tail. It has been supposed to be the second comet of 1748 (No. 70), the elements of which were computed by Bessel from three imperfect observations of Klinkenberg.

\* The Editor follows the authority of Professor Schumacher in naming this comet; though, under the circumstances, he would have preferred the title of Schweizer-Bond, as recalling the facts of its discovery.

## CAMBRIDGE, U.S. Great Refractor. (Prof. W. C. Bond.)

1849.	Cambridge M.T.	A.R. 1849°	Dec. 1849°	No. of	Star of
	h m s	h m s	° ' "	Comp.	Comp.
April 11	10 56 29	15 9 6.1	+28 33 27	8	<i>a</i>
12	7 57 58	15 3 36.3	28 20 9	5	<i>a</i>
	15 36 21	1 27.2	28 14 48	5	<i>a</i>
14	10 35 59	14 48 12.1	27 36 34	5	<i>b c</i>
17	8 48 52	14 20 40.6	25 54 23	3	<i>d</i>
19	9 8 51	13 56 38.9	24 0 59	5	<i>e</i>
21	8 24 56	13 28 20.5	21 20 9	8	<i>f</i>
24	8 49 33	12 35 11.4	15 4 58	8	<i>g</i>
	9 44 33	34 26.5	14 59 1	1	<i>h</i>
26	8 36 58	11 55 3.1	9 25 5	5	<i>i</i>
27	10 20 28	11 32 32.6	+ 5 59 3	10	<i>k</i>
May 1	10 36 46	10 11 15.6	- 7 1 48	4	<i>l</i>
2	9 36 6	9 53 54.3	9 44 28	5	<i>m</i>
10	8 47 49	8 11 17.9	-23 26 34	2	<i>n</i>

Referred to the mean equinox of 1849°0.

## Mean Places of Stars of Comparison for 1849°0.

		R.A.	Dec.	Mag.	
		h m s	° ' "		
<i>a</i>	B.Z. 366	15 6 23.25	+28 30 5.3	8.9	Star double, <i>n</i> <i>f</i> used.
<i>b</i>	„ 366	14 48 7.66	27 25 9.5	9	By intermediate star, 13th mag.
<i>c</i>	„ 366	14 51 39.77	27 25 25.7	8	
<i>d</i>	„ 462	14 16 16.33	26 1 29.9	7	
<i>e</i>	„ 412	13 59 19.81	24 6 46.3	8	
<i>f</i>	„ 460	13 27 28.03	21 25 18.4	9	Mean with H.C. 25118.
<i>g</i>	„ 360	12 37 49.79	15 11 35.5	8	
<i>h</i>	„ 360	12 34 26.48	14 59 21.1	9	Comet 20'' from the star.
<i>i</i>	B.A.C. 4072	11 57 31.10	9 34 17.7	3	By an intermediate star.
<i>k</i>	Weisse 573	11 32 43.06	+ 5 58 37.1	8	Mean with H.C. 22110.
<i>l</i>	H.C. 20153	10 15 44.05	- 7 0 45.6	8	By an intermediate star.
<i>m</i>	B.Z. 217	9 54 44.82	9 42 19.8	8	
<i>n</i>	B.A.C. 2827	8 18 33.01	-23 33 31.2	6	

“The comet has usually presented an apparently solid but very minute central point, admitting of accurate observation.”

## PULKOWA.

(M. Otto Struve.)

1849.	Pulkowa Sid. T.	R.A.	Par.	Dec.	Par.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>		<sup>°</sup> <sup>'</sup> <sup>"</sup>	
April 17	11 59 50.7	14 23 7.04	-0219 P	+26 4 8.7	+597 P
19	15 23 49.3	13 57 56.51	+0135	24 7 26.9	597
23	11 57 40.7	12 58 21.75	-0095	17 59 38.6	672
26	12 38 41.5	11 59 25.41	+0058	10 3 42.4	764
27	12 36 52.2	11 38 35.72	0086	6 54 49.0	799
28	12 43 37.5	11 17 29.61	0125	3 36 5.3	833
29	13 48 58.6	10 55 45.31	0231	+ 0 6 47.3	863
May 1	14 0 34.6	10 15 59.28	+0278 P	- 6 17 19.1	+890 P

On May 1 the comet was compared with a star the place of which was taken from B.A.C. and Bessel's zones; for the previous days the stars of comparison have been determined by meridian observations. M. Otto Struve saw the comet with the naked eye as bright as 4.5 mag. star.

## LIVERPOOL.

Equatoreal.

(Mr. Hartnup.)

1849.	Greenwich M.T.	R.A.	N.P.D.	Star.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>	
April 26	11 16 4.4	11 56 52.53	80 18 34.7	4168 B.A.C.
"	13 28 49.0	54 57.34	80 35 37.1	4114 "
28	11 38 25.2	14 32.14	86 51 37.0	3900 "
"	11 53 43.1	11 14 18.99	86 53 51.6	— "

"Corrected for refraction and parallax. The horizontal parallax is taken from Mr. Graham's ephemeris. The comet had a well-defined nucleus of about 2" diameter, surrounded by a strong nebulous light, and no tail could be seen."

## HAMBURG.

(M. Rümker.)

1849.	Hamburg M.T.	R.A.	Dec.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
April 20	11 7 35.4	13 44 54.91	+22 57 40.1
23	10 43 9.7	12 56 41.57	17 47 28.6
24	9 52 43.8	38 43.27	15 32 4.5
25	9 26 37.4	12 19 27.35	12 56 37.4
29	10 5 5.9	10 55 38.24	+ 0 5 50.0

## BERLIN.

(Dr. Galle.)

1849.	Berlin M.T.	R.A.	Dec.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
April 23	10 46 37	194 12 2.6	+17 48 36.9*
26	9 51 39	179 42 53.5	9 58 45.4
27	9 17 3	174 36 46.1	+ 6 53 23.4

## Elements.

M. Hensel (Leipsic).

Dr. Luther.

T. 1849, June 8.21239, Berlin M.T. 1849, June 8.21067, Berlin M.T.

$\pi$ ....	267 4 22.8	} Mean Eq. 1849.0.	267 4 12.91	} Mean Eq. 1849.0.
$\delta$ ....	30 31 51.1		30 31 49.74	
$i$ .....	66 57 56.9		66 57 32.16	

Log.  $q$  9.951550

9.9515556

Motion direct.

\* This observation is corrected.

Dr. d'Arrest has calculated elements on the same observations, and finds no sensible difference from M. Hensel's elements, which represent the observations nearly completely.

M. Hensel's elements are deduced from the corrected observations of Mr. Graham, April 14; Dr. Petersen, April 20; Dr. Galle, April 16. Dr. Luther has calculated his elements on the observations of April 14, 20, 26, not taking parallax into account.

Parabolic, J. D. Runkle.			Hyperbolic, G. P. Bond.		
Perihelion Pass., June 8 <sup>h</sup> 1882 <sup>h</sup> 8, G.M.T.			June 6 <sup>h</sup> 7547, G.M.T.		
Long. Per...	267° 3' 33"	} Mean Eq. 1849° 0.	265° 17' 43"	} Mean Eq. 1849° 0.	
„ Node.	30 32 53		30 21 6		
Inclination..	66 54 10		68 14 40		
log. Per. Dist.	9.9513114		9.9557110		
Motion direct.			Eccentricity 1.0670345 Motion direct.		

“It is to be hoped that observations after the perihelion may be obtained, to determine whether there be a decided eccentricity to the orbit. The above hyperbola deviates about 1' 30" of arc from the observation on May 10th. (*From Professor Bond.*)

“We obtained a place of a star of the 12th mag., supposed to be *Metis*, April 12th, 16<sup>h</sup> 26<sup>m</sup> 22<sup>s</sup>, Cambridge M.T.

R.A.	21 <sup>h</sup> 27 <sup>m</sup> 32 <sup>s</sup> .97	} Mean Eq.
Dec. — 19°	2' 22".9	
		Jan. 1st, 1849.

“It has been observed two or three times since, but with great difficulty in distinguishing it from fixed stars of the 12th and 13th magnitudes.”

*Ephemeris.* By Dr. Luther. From his own Elements.

Berlin Mean Noon.

	R.A.	Dec.	Log. Δ
1849.			
April 8	231 56 51.9	+ 29 6 44.5	9.707595
12	226 48 3.3	28 28 55.4	.630195
16	219 11 27.0	26 51 33.3	.542472
20	207 52 34.9	23 34 0.9	.446923
24	191 40 6.7	16 33 39.4	.357808
28	171 22 16.0	+ 4 52 31.0	.312269
May 2	151 18 24.6	— 7 58 44.1	.342196
6	135 26 22.4	17 17 51.5	.422728
10	124 10 0.4	22 51 13.8	.513826
14	116 14 4.4	— 26 6 33.8	9.598063

*On calculating the Moon's Place for Ephemerides.*

By S. M. Drach, Esq.

In this paper (read at the last April meeting) the author shews that by a modification of Burckhardt's method the lunar co-ordinates are obtainable with a less degree of labour and number

of equations; for this purpose adding the sexagesimal equations in seconds to the argument of the next inequality, the circumference of which is divided into 16,000,000 parts. The arguments are likewise increased by twice or thrice the annual equation, which, if attended to by Burckhardt, would have removed some of his principal 32 small equations, allowing several of them to be condensed into one table of double entry. As the paper chiefly consists of algebraical formulæ and numerical calculations, it could be only *announced* to the meeting.

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*On the Determination of the most probable Orbit of a Binary Star from the assemblage of a great number of observed Angles of Position.* By Sir J. F. W. Herschel, Bart. *With some Remarks by the President on a Solution of the same Problem by M. Yvon Villarceau.*

In this paper Sir John Herschel refers generally, for the principle of his method, to a paper published by him in the fifth volume of the *Memoirs* of this Society, the paper (we may remark) in which was given an exposition of the principles by which the orbit of a double star was for the first time actually determined. He now states his conviction that the method there expounded is, on the whole, the best that can be employed; and the object of the present paper is, retaining the original principle (namely, of using only the measured angles of position, and rejecting entirely the measures of distance), and retaining the first step of the original method (namely, of smoothing down the irregularities of the angles as measured, by laying them down graphically, the angles for abscissæ and the corresponding times for ordinates, and then drawing a curve by hand through the points so found, and using that curve as the representation of the real relation between the angles and the times, and measuring from it the times corresponding to angles which differ by  $5^\circ$ , or by  $10^\circ$ , or any other convenient difference); retaining the original method thus far, to complete the investigation by a process entirely algebraical and arithmetical.

Supposing the times corresponding to equal intervals of angle to be taken from the curve above mentioned, the next thing required is  $\frac{dt}{d\theta}$  for every  $5^\circ$  or every  $10^\circ$ , &c. This is to be found by the following formula, which requires for application only the finite differences of  $t$  for the equidistant values of  $\theta$ ,

$$\frac{dt}{d\theta} = \frac{1}{\Delta\theta} \left\{ \frac{\Delta t}{1} - \frac{\Delta^2 t}{2} + \frac{\Delta^3 t}{3} - \&c. \right\}$$

The next step is, to infer from this the true apparent distance of the stars, as it ought to be measured by a perfect micrometer or measuring instrument. Now every determination of an orbit of double stars proceeds on the assumption of an attraction between the two components, and this requires the supposition of descrip-

tion of areas proportional to the time, both in the orbit really described and in the projection of the orbit which we see. Hence we must have  $\epsilon^2 \cdot \frac{dt}{d\theta} = \text{constant} = 100$  (the unit of the radius vector

being for the present arbitrary), and therefore  $\epsilon = \sqrt{100 \cdot \frac{dt}{d\theta}}$  or  $= \sqrt{-100 \frac{dt}{d\theta}}$ , according as  $\frac{dt}{d\theta}$  is positive (that is,  $\theta$  increasing in the direction *n f s p*) or negative. Sir John adopts for the unit of angles one degree, and for the unit of time one year.

A series of radii vectores being thus found, corresponding to certain values of  $\theta$ , the next step is to form from these in numbers the corresponding values of the rectangular co-ordinates  $x = \epsilon \cdot \cos \theta$   $y = \epsilon \cdot \sin \theta$ . And, assuming that the force of attraction between the two stars follows the law of the inverse square of the distance, and therefore that the curve really described is a curve of the second order, and consequently that the apparent curve is a curve of the second order, we must make these numerical values of  $x$ ,  $y$ , (as  $x_1, y_1, x_2, y_2, x_3, y_3$ , &c.) satisfy the equation  $0 = 1 + \alpha x + \beta y + \gamma x^2 + \delta xy + \epsilon y^2$ , an equation containing 5 unknown constants. As the number of equations will generally exceed 5, it will be proper to combine them by the method of least squares; and the only question is, what is the function of  $x$  and  $y$  which shall be supposed *a priori* liable to equal error in all? Sir John Herschel tacitly assumes that the function  $B = 1 + \alpha x + \beta y + \gamma x^2 + \delta xy + \epsilon y^2$  is the quantity which with equal weight throughout is to be made as small as possible, or that  $\Sigma (B^2)$  is to be minimum. The equations given by this consideration are easily formed, and then  $\alpha, \beta, \gamma, \delta, \epsilon$ , can be determined.

From these numbers the numerical values of the more convenient elements of the apparent ellipse may be found, and from them the elements of the real ellipse may be found. The formulæ for all these transformations are given at length by Sir John Herschel, and they are less complicated than might at first have been feared.

Thus far the elements necessary to produce geometrical coincidence of the concluded orbit with the observed orbit are alone determined. The next operation is to determine those elements which relate to the motion in the concluded orbit. For this purpose, angles being taken from the curve based on the graphical projection, and these angles (which relate to the apparent orbit) being converted into angles in the true orbit by the formulæ lately found, and thus exhibiting true anomalies on the true ellipse, the excentric anomalies are found at once by the formula  $u - e \sin u$ , and the mean anomalies are found. Then every one of these angles gives an equation of the form

$$w_1 = k \cdot t_1 - l,$$

from the assemblage of which the constants  $k$  and  $l$  can be found by the method of least squares; and then we have all that is required to form the mean anomaly for any other time  $t$ , and con-

sequently (as the elements of the ellipse are known) to form the excentric and true anomalies.

The conversion of a place thus computed in the real orbit into one in the apparent orbit, and the comparison of the distance computed on the arbitrary scale with the distance measured with the micrometer, and the inference as to the true value of the units of the arbitrary scale, are steps which require no particular explanation.

Sir John Herschel holds out the hope of following up this exposition with the details of the application of his method to the star  $\gamma$  *Virginis*.

As an Appendix to Sir John Herschel's paper, it is proper to add that papers have been received by Sir John Herschel from M. Yvon Villarceau (namely, a note on the double star  $\zeta$  *Herculis*, dated 1849, February 1, a note on the double star  $\alpha$  *Coronæ*, dated 1849, March 30, and a letter dated 1849, April 1, containing an exposition of M. Yvon Villarceau's methods), which have been communicated more or less completely to the *Académie des Sciences* of France, and which therefore cannot be received in the ordinary way as a communication to this Society. It is, however, the wish, both of Sir John Herschel and of M. Yvon Villarceau, and it appears in every way desirable, that their results should be made known to this Society, both as containing instructive expositions of a very elegant general method and very curious applications of it, and also as bearing upon any questions which may arise as to the similarity or priority of the methods of Sir John Herschel and M. Yvon Villarceau.

Assuming the law of gravitation, and consequently the law of elliptic movement, as applying generally to the relative motion of two stars in a binary system, M. Yvon Villarceau remarks that the projection of this curve upon the spherical sky (or rather upon a plane perpendicular to the visual ray) will be a curve of the second order, whose equation will be,

$$F = ay^2 + bxy + cx^2 + dy + ex + f = 0,$$

the origin of co-ordinates being one star regarded as a fixed centre of attraction of the other. The object of the next process must be, to adopt this general equation to the particular observations from which the orbit is to be deduced: and here it is to be observed that M. Villarceau does not confine himself either to the measured angles of position or to the measured distances, but uses both, for the formation of the numerical values of  $x$  and  $y$  corresponding to every observation. Having these numerical values of rectangular co-ordinates, and paying no respect (for the present) to the intervals of time between the observations, the following is the method used to accommodate *geometrically* the curve of the second order to the observed co-ordinates:—

The principle assumed is, that the constants  $a$ ,  $b$ ,  $c$ , &c. shall be so determined that if the resulting curve be drawn, and if from

every observed place a normal (usually a very short line) be drawn to the curve, then the sum of the squares of these normals, each multiplied by its proper weight, shall be a minimum. This principle, it is almost unnecessary to remark, is imperfect, inasmuch as it does not in any way take cognisance of the laws of movement as connected with *time*; but it will frequently be doubtful, in a problem of such difficulty, whether it is not best to neglect a condition, even of the most essential kind, for the sake of making the solution more simple.

Putting  $b^2 D^2$  for  $\left(\frac{dF}{dx}\right)^2 + \left(\frac{dF}{dy}\right)^2$ , and  $p$  for the weight of each determination, M. Villarceau arrives thus at the following equations:—

$$\Sigma \cdot \frac{p F \frac{dF}{da}}{D^2} = 0, \text{ or } \Sigma \cdot \frac{p y^2 F}{D^2} = 0$$

$$\Sigma \cdot \frac{p F \frac{dF}{db}}{D^2} = 0, \text{ or } \Sigma \cdot \frac{p x y F}{D^2} = 0$$

&c.,

and he shews how, supposing an ellipse roughly drawn by hand, the value of  $D$  may be found graphically; and it will then be possible to solve the equations.

The projected ellipse being thus determined, the real ellipse will be found from the consideration that the origin of co-ordinates is the projection of the focus of the real ellipse, while the centre of the observed ellipse is the projection of the centre of the real ellipse. The formation of the corresponding equations is a not difficult problem of analytical geometry. This transformation, however, is not required till all the other operations are completed.

The points determined by observation are not generally found exactly upon the projected ellipse. In order to have points upon the ellipse which shall be the subjects of further investigation, M. Villarceau transfers the observed points to the ellipse by drawing normals to the ellipse, and taking, instead of the point actually determined by observation, the foot of its normal. If  $x'$  and  $y'$  be the co-ordinates determined from observation,  $x$  and  $y$  those of the foot of the normal, then

$$x = x' - \frac{\frac{dF}{dx}}{\left(\frac{dF}{dx}\right)^2 + \left(\frac{dF}{dy}\right)^2} \cdot F(x', y')$$

$$y = y' - \frac{\frac{dF}{dy}}{\left(\frac{dF}{dx}\right)^2 + \left(\frac{dF}{dy}\right)^2} \cdot F(x', y')$$

with sufficient exactness.

The next point is, to introduce the consideration of time; and this is to be done by making the areas described by the radius vector in the projected ellipse proportional to the time. The areas can be expressed in terms of the corrected co-ordinates and the constants without much difficulty, the whole of these admitting of further correction if necessary. M. Villarceau remarks that if there are four observed places, the solution of the four equations  $F(x, y) = 0$  will give four of the quantities  $a, b, c, d, e$ , in terms of the fifth; that these four observations will give three areas between which there are two equations of proportion; and that thus, besides the determination of the fifth coefficient, we shall have an equation of condition which must be satisfied, or whose failure will prove that our operations or assumptions are in some part erroneous. When there are more than four equations, all can be used in methods analogous to those which are well understood in other investigations, for correcting the result.

We must, however, express our opinion that this part of the operation appears the most obscure, as well as the most delicate and difficult, of the whole.

M. Villarceau remarks that the final determination of elements will in all cases require observations separated by a considerable interval from the rest.

M. Villarceau has lately communicated to the *Académie* another method.

The following are the principal results in the two cases which M. Yvon Villarceau has specially examined:—

In the instance of  $\zeta$  *Herculis*, the stars are so unequal that there can be no possibility of confusion between the two. It was seen double in 1782, but there is reason to think that it was seen as only one star between 1795 and 1802, and also between 1828 and 1832. M. Struve, expressing himself very doubtful, seemed to suppose that the periodic time might be about 14 years. (See the *Mensura Micrometrica*.) A valuable series of observations, however, having been made at Pulkowa, extending to 1847, the whole of which have been communicated to M. Yvon Villarceau, he has deduced from them an orbit in which the excentricity  $= \sin 27^\circ$  nearly, and the periodic time is  $36\frac{1}{2}$  years. The measure of 1782 and those from 1826 to 1847 appear to be represented with all desirable exactness. (In comparing the computed and observed angles of position, we are glad to see that M. Villarceau has converted their effects into expressions measured by seconds of arc.) The remarks, too, made by M. Struve about the time of the union of the two stars observed by him correspond exactly to the positions given by M. Villarceau's elements. Those of Sir W. Herschel do not correspond. M. Villarceau suggests that, at a time when the small star really was hidden, Sir W. Herschel may have been misled by a false image of the large star; and that, when the image of the star was deformed, he may have estimated the deformation in the wrong direction. He desires, however, specially to submit these conjectures to the judgment of Sir John Herschel; and we

trust that Sir John Herschel will not decline to undertake the honourable task to which he is invited.

M. Villarceau concludes with pointing out that this star presents a remarkable illustration of the amount of uncertainty which may rest upon the determination of double-star elements, when based upon a limited series of observations. If we had only to satisfy the observations extending from 1828 to 1847 (or through more than one-half of a revolution), we might have represented them by systems of elements in which the excentricity varies from 0.44 to 1.63, that is, the orbit might have been an ellipse, a parabola, or a hyperbola.

In the instance of *Coronæ* there is a difficulty of a totally different kind. The two stars are so very nearly equal in magnitude and similar in colour, that, when observations are interrupted for a long time, it is impossible to say whether that which is adopted as the zero-star before and after the interruption is the same; and it is therefore necessary in some cases to make double computations, on the two suppositions that the first star, or the second star, is that to which the measures are referred in other observations.

From the observations to which they had access, M. Struve, Sir John Herschel, and M. Mädler, concluded that the periodic time of this star was 43 or 44 years. M. Villarceau, however, has had access to the observations made at Pulkowa from 1826 up to 1847, and has treated them in the following manner:—

Of fifteen observations, four were rejected, on account of manifest errors in the distance only. From the remaining eleven, relations were obtained between the elements, which leave them dependent upon an indeterminate quantity which is arbitrary between very wide limits. The observations of Sir John Herschel in 1823, and of M. Struve from 1826 to 1847, may be represented with sufficient accuracy by ellipses in which the periodic time ranges from 38 to 190 years. To fix this indeterminate quantity, we may take Sir W. Herschel's observation of 1781 or that of 1802 (with a slight alteration sanctioned by Sir John Herschel). If we fix the indeterminate quantity by the observation of 1802, M. Villarceau finds that the observation of 1781 is also satisfied, provided that the position of the stars be reversed; that is, provided that it be assumed that the other star has been used as the zero, which is perfectly admissible. Thus is obtained an orbit with a periodic time of 66 years.

But if we reverse the position of the stars in 1802, which is admissible, it is found that the observation of 1781 is satisfied without reversion. The periodic time thus obtained is 43 years.

It is remarkable that in these totally different solutions the excentricity is sensibly the same, namely, 0.47.

In both cases the remaining errors are so small, in comparison with the probable errors, as to leave the two solutions equally entitled to our reception. For the final judgment between them, M. Villarceau refers to some remarks of Sir W. Herschel, unaccompanied by measures. Although there is some doubt in the

interpretation of these, M. Villarceau thinks that upon the whole the solution which gives a period of 66 years is the more probable. He remarks, however, that in four years at the furthest the doubt will be settled. In 1853·677 the angle of position given by the 66-year solution will be  $303^{\circ}44'$ , while that given by the 43-year solution will be  $356^{\circ}30'$ , leaving a difference upon which there can be no doubt. The distances will be respectively  $0''.51$  and  $0''.77$ , but between these it might be difficult to pronounce.

*On the Practicability and Advantages of obtaining a Sea-rate for a Chronometer.* By H. Toynbee, Esq., late Commander of the Ellenborough, East Indiaman.

Having found by experience that lunar observations taken Sun E. and Sun W.\* give very different Greenwich Times, Capt. Toynbee has adopted the following method of combining his results in settling the rate and error of his chronometer:—

Having made numerous careful sets of lunar distances, Sun E. and Sun W., whenever an opportunity occurred, Captain Toynbee works out the error and rate of his chronometer as in the following instance. Having found from the means of several sets on several days,

	Sun E. of Moon. Error Chron.		Sun W. of Moon. Error Chron.
1848. <sup>d</sup>	<sup>m</sup> <sup>a</sup>		<sup>m</sup> <sup>a</sup>
Aug. 24 <sup>o</sup> 0	—3 31·4	Sept. 3 <sup>d</sup> 4	—6 <sup>m</sup> 1·3
Sept. 18 <sup>o</sup> 5	—6 52·2		
Loss in 25·5	—3 20·8	Daily rate—	0 <sup>m</sup> 7 <sup>s</sup> ·88

Now, bringing up the error found on Sept. 3·4, Sun W., by  $15^{\circ}1' \times -7^s\cdot88$ , or  $1^m 59^s\cdot0$ , we have the following chron. errors:—

Sept. 18 <sup>o</sup> 5	Sun E., Chron. slow	6 52·2
	Sun W. ....	8 0·3
	Mean	7 26·3

With this final error for Sept. 18·5 and rate  $-7^s\cdot88$ , the chronometer being brought up to October 1st, was found to be slow  $9^m 4^s\cdot8$ ; the flash of the signal-gun at Madras shewed it actually slow  $9^m 20^s\cdot3$ , i. e. the error in longitude was only about  $4'$ . It should be remarked that the chronometer had fallen from its stand in a gale of wind on August 20th, and that Madras was made without reference to any other rate or error than that deduced above, i. e. from lunar distances observed after the accident.

A more extended series is added to shew the coincidence of the partial results obtained by Capt. Toynbee on his return:—

\* There are many reasons why lunar distances from the sun are preferred to those from the planets and stars, and we believe they are more commonly observed.

		Sun E. of Moon. Chron. Error.			Sun W. of Moon. Chron. Error.
1849.	d	<sup>m</sup> <sub>s</sub>	1849.	d	<sup>m</sup> <sub>s</sub>
Dec.	20·3	—18 29·0	Jan.	0·4	—20 45·4
1849.					
Jan.	17·2	22 11·2		30·3	24 35·0
Feb.	16·6	25 59·9	March	0·8	28 15·7
March	18·4	—30 1·0		27·0	—31 37·3

from which the following daily rates were concluded, viz.,

Sun E. —7<sup>s</sup>·96, —7<sup>s</sup>·52, —8<sup>s</sup>·09; Sun W. —7<sup>s</sup>·68, —7<sup>s</sup>·48, —7<sup>s</sup>·69

The final chronometer-errors are found thus:—The error, Sun E., of Dec. 20·3, is brought up to Jan. 0·4 by the rate —7<sup>s</sup>·96, and a mean is taken between this and the error actually obtained, Sun W., at the same date. In the same way the error, Sun W., on Jan. 0·4, is brought up to Jan. 17·2 by its proper rate —7<sup>s</sup>·68; and a mean is taken between this and the error, Sun E., at the same date. Thus Capt. Toynbee finds, for the final errors of his chronometer,

		Chron. Error.			Chron. Error.
1849.	d	<sup>m</sup> <sub>s</sub>	1849.	d	<sup>m</sup> <sub>s</sub>
Jan.	0·4	—20 21·4	March	0·8	—27 53·4
	17·2	22 35·2		18·4	30 19·5
	30·3	24 13·4		27·0	—31 22·2
Feb.	16·6	—26 22·5			

The *actual* error, on March 27 = —31 13·6

Capt. Toynbee says: “I felt such confidence in my chronometer (Dent, 1735), corroborated as it was by all the lunar observations taken during the voyage, that on my return to England, though no land had been seen since leaving Cape Town—a northerly gale blowing as I entered the English Channel—I ventured to steer for passing within a few miles of St. Agnes Light, and sighted it in the middle of the night, bearing as my calculation had led me to expect.”

The sextant employed was by Cary, with blue glasses; and care was taken that the telescope was always drawn out to the same length, the wires always in the same position, the elevating screen always raised the same quantity, and the same shades invariably used for the observation itself, and for the determination of index-error. The measured semidiameter of the sun seldom agreed with the *Nautical Almanac* nearer than within 3" or 4"; and the lunar distances, Sun E., generally made the chronometer from 40<sup>s</sup> to 50<sup>s</sup> faster than the lunar distances Sun W.\*; but, from the mode of treatment, errors of this kind have no influence on the rates or on the concluded errors.

Capt. Toynbee adds: “I have hitherto limited myself to observations of the sun and moon, but in a future voyage it is my intention to apply the same method to the angular distances between the moon and the planets and stars, which will probably allow of a rate being determined at an earlier period of a voyage.” If the observations can be as well made, the results would certainly be

\* This looks like a constant error in the observer, or in the dark shade. The results from different *distances* seem accordant.

preferable, since the final error would be obtained immediately; and if the east and west distances were properly combined, the instrumental errors and errors of observation would be eliminated. This is indeed the practice of the best navigators, who do not regard a little extra trouble when the safety of their vessel is in question, and of all competent observers who use lunars in geographical determinations.

In pointing out the advantages of this method of rating, its *independence* is very properly insisted upon. The seaman who employs it relies on his shore-rate for a very short time, and has a sufficient check even upon that. Capt. Toynbee thinks (and it is an almost universal opinion) that the sea-rate of a chronometer differs considerably from the shore-rate; and this is probably true to some extent, in some cases, though Mr. Hartnup, from his experience at Liverpool, has come to a different conclusion. As a general rule, Mr. Hartnup finds that a first-rate chronometer, which is not exposed to *sudden* changes of temperature, goes at sea, keeping pretty nearly the same rate as in his observatory, *at the same temperature*, if it rests nicely in its gimbals. It is presumed that a steady place is selected for the chronometers, and that they are not exposed to extraordinary magnetic influence.

Captain Toynbee found the rate altered by disturbing his cargo. It was about  $-7^s.8$  before his arrival at Calcutta, and kept steady for a few days until the ship began to discharge, when it gradually changed to  $-6^s.5$ . The old rate was, however, taken up again at sea.

### *Ephemeris of Iris.* By Mr. Pogson.

For 12<sup>h</sup> Greenwich M.T.

1849.				1849.			
R.A.				R.A.			
h m s				h m s			
N.P.D.				N.P.D.			
° ' "				° ' "			
H.P.				H.P.			
° ' "				° ' "			
May 16	9 48 36.81	83 5 44.9	3.56	June 19	10 24 49.73	85 28 32.7	
18	50 24.56	11 12.1		21	27 15.14	39 52.9	2.92
20	52 15.40	17 3.8	3.47	23	29 42.00	85 51 30.0	
22	54 9.22	23 19.5		25	32 10.24	86 3 23.6	2.86
24	56 5.88	29 58.8	3.39	27	34 39.78	15 33.2	
26	9 58 5.27	37 1.2		29	37 10.57	27 58.4	2.81
28	10 0 7.26	44 26.2	3.31	July 1	39 42.54	40 38.6	
30	2 11.71	83 52 13.2		3	42 45.65	53 33.5	2.77
June 1	4 18.52	84 0 21.8	3.24	5	44 49.82	87 6 42.5	
3	6 27.54	8 51.3		7	47 25.02	20 5.1	2.72
5	8 38.70	17 41.4	3.17	9	50 1.20	33 40.0	
7	10 51.90	26 51.6		11	52 38.34	87 47 29.9	2.68
9	13 7.07	36 21.5	3.10	13	55 16.40	88 1 31.5	
11	15 24.12	46 10.6		15	10 57 55.37	15 45.8	2.64
13	17 42.98	84 56 18.6	3.04	17	11 0 35.21	30 12.6	
15	20 3.58	85 6 45.2		19	11 3 15.91	88 44 51.9	2.60
17	10 22 25.85	85 17 30.0	2.98				

"The right ascension is reckoned from the true equinox, and the ephemeris is corrected for aberration."

## ROYAL ASTRONOMICAL SOCIETY.

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G. B. AIRY, Esq., President, in the Chair.

John Ashton Nicholls, Esq., Ardwick Place, Manchester; and  
James Nasmyth, Esq., Patricroft, near Manchester;  
were balloted for and duly elected Fellows of the Society.

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The Astronomer Royal resigned the Chair to the Rev. R. Sheepshanks, and then delivered to the Society an oral statement, illustrated by models, "On Instruments adapted to the Measure of small Meridional Zenith Distances."

The Astronomer Royal remarked that there were three distinct ranges of observation, for which three distinct classes of instruments had been employed. The first and most comprehensive included the observations for zenith distances throughout the whole extent of the meridian, from the north horizon to the south horizon: to which observations the mural circle and similar instruments were adapted. It was evident that constructions adapted to secure this extent of observations in all their generality could scarcely be expected to avail themselves of the advantages peculiar to observations confined to one part of the heavens; and accordingly, in nearly every instance in which observations on a more limited arc of the meridian were sufficient, instruments of the other classes had been employed. The second class of instruments might be included under the name of zenith sector. With this instrument, by limiting the range of observation to six or seven degrees on each side of the zenith, a part of the arc of meridian was embraced which sufficed for most geodetical purposes; that part, both from the smaller proportion of obscuration by clouds and from the smaller uncertainty attending the calculation of refraction, was better in an astronomical point of view than the rest; the instrument also might, with great portability, be made of large dimensions, with long telescope and long plumb-line, two advantages which were highly valued in the last and in the beginning of the present centuries. Generally, its use had been confined to geodesy; although it must not be forgotten

that one of the most celebrated specimens of it, namely, Bradley's zenith sector, was constructed solely for astronomical observations at a fixed observatory; still, however, that instrument had in practice been confined to the observation of a single star passing the meridian within two minutes of the zenith, and it might thus be considered as included in the third class. The third class included those instruments specially adapted to the observation of stars passing within still smaller distances of the zenith. It is evident that these, besides possessing in the highest excellence the astronomical advantages ascribed to the second class, might be expected to enjoy extraordinary freedom from the distortions produced by the weight of the instrument, and might also give great facility for measures of zenith distance by the simple use of the micrometer or the spirit-level. This was the class of instruments which the Astronomer Royal proposed as the subject of the present statement.

The Astronomer Royal announced that his discussion would be confined to a critical description of three instruments: the Greenwich 25-foot Zenith Tube, now dismantled; Struve's Prime Vertical Instrument, now in use; and a construction of a Reflex Zenith Telescope, proposed by himself, but not yet actually constructed. The second of these instruments, it is true, may be used for zenith distances of several degrees, but its peculiar advantages are connected with its use for very small zenith distances. These three instruments would be found to embody, as essential parts of their construction, the three different methods of referring to the zenith in use in modern times, namely, the plumb-line, the spirit-level, and the reflexion from the surface of quicksilver.

I. The Greenwich Zenith Tube was planned and constructed by Troughton, several years before Mr. Pond's direction of the Royal Observatory ceased; although, from some delays in regard to the small but essential parts, it was not brought into use till within two years of that time. It consisted of a telescope 25 feet long, revolving in azimuth on a pin at the bottom and between guides near the top, but absolutely confined to the vertical direction. Its range of observation was therefore necessarily limited to that angle in which the injurious effect of obliquity of the pencil upon the image of the star is insensible; and practically it was confined to the single star  $\gamma$  *Draconis*, at two minutes only from the zenith. The aperture of the object-glass was 5 inches; the diameter of the tube at the top 6 inches, which increased at each successive step downwards (the tube being made in five separate lengths), till it was 10 inches in diameter at the bottom. About 6 inches below the object-glass, on the outside of the tube, was a reel of silver wire; the wire passed upwards over a wheel admitting of a certain degree of end-motion, and then passed through a hole in the side of the tube, and rested between the threads of a screw, within the tube and 4 inches from its top, whose axis was horizontal (a convenient arrangement for small movements of the point of suspension), and then descended vertically. Within the great tube was a small vertical tube, nearly

an inch in diameter; the top of this tube was about 10 inches below the object-glass, and here the small tube was in contact with the side of the great tube; the tube extended to the lower end, at which part it was separated about 2 inches from the side of the great tube. The plumb-line descended through this vertical tube, and passed through a hole in the bottom plate of the telescope, and there it carried the plumb-bob in a cup of water supported by hooks upon the lower plate. Just above the top of the small tube, or 9 inches below the top of the great tube, and consequently 5 inches below the point of free suspension of the wire, a micrometer-microscope was fixed externally to the tube, on the same side on which the wire tube is placed, for reading the position of the wire. Very close to the bottom of the tube, but on the side opposite to that on which the wire tube is placed, another micrometer-microscope was placed for reading the position of the lower part of the wire; the wire tube here was perforated to permit vision of the wire. This microscope was almost completely buried in the great tube (its micrometer and eye-piece alone projecting from it); it was not, however, firmly screwed down; it was thrust in by hand into a hole (where it was held by friction only) in a sliding-plate within the great tube, which sliding-plate was moved by external screws. It is evident that, if these microscopes were firm, and if the wire retained in all positions of the instrument its peculiarities of curvature, &c. in constant relation to the *instrument*, while its general direction of dependence had respect to nothing but the *direction of gravity*, the readings of the micrometer-microscope would give most accurate information upon the position of the great tube with respect to the vertical (the observation of the sides of the plumb-wire being exceedingly delicate). Below the lower plate of the great tube was the eye-piece of the telescope, a 4-glass diagonal eye-piece, its eye-end projecting horizontally below the eye-piece of the lower micrometer-microscope, and nearly to the same distance. With this was viewed the wire (carried by a micrometer, to which was given for distinction the name of Grand Micrometer), by which the bisection of the star was effected. The lower plate of the telescope was supported by four arched pieces of brass, attached to the lower plate at its circumference, and united about 6 inches below its centre; and at the place of union was the pin which turned in the foot-plate. The intervals between the brass arches left room for the eye-piece, the micrometer, and the plumb-line cup. The foot-plates had adjusting screws, which were, however, very rarely used. The upper guides of the great tube were about 5 feet below the top; they were carried by an enormous iron tube, which inclosed the great tube to within about 4 feet of the bottom, and was there supported by large iron arches rising from four large iron pillars, which at some distance surrounded the pier of the foot-plates, being placed at the angles of a square, and leaving a clear space of  $4\frac{1}{2}$  feet between each pillar and that opposite to it.

When the present Astronomer Royal took charge of the Royal

Observatory. he found the Grand Micrometer of this instrument in the following state :—The wire-plate of the micrometer carried also the long heavy eye-piece projecting sideways more than 6 inches ; the long micrometer-screw extended nearly from side to side of the lower plate of the tube, was supported at its extremities by projections from that lower plate, and was tapped through the case of the diagonal mirror, thus acting at a distance of about 1 inch from the wire-plate. The supports of the ends of the screw, upon whose firmness the correctness of the action of the screw must entirely depend, were thin vertical arches attached to the bottom plate only by small thumb-screws, and these arches sustained the force of the micrometer-screw sideways. Three arrangements more entirely opposed to the just principles of construction of micrometers can scarcely be conceived. The wire-plate ought not to be strained sideways by a projecting weight, and ought not to carry any weight which will increase the friction of its movement ; the action of the screw ought to be in the plane of motion of the wire-plate ; and the supporting point, or *appui*, of the screw ought to be perfectly firm.

The following changes were therefore made without delay. The long screw was laid aside, and in its place was used a micrometer-screw or stalk attached to the end of the wire-plate in the usual way ; and the micrometer was made in every respect like an ordinary micrometer, the micrometer-head carrying the concave-screw which embraces the stalk and draws it towards the micrometer-head, the action of the screw being in the plane of the wire-plate and directed longitudinally across the middle of the wire, and the drawing action of the screw being resisted by springs at the opposite end of the wire-plate. The motion of the micrometer was limited in this construction to about one-tenth of the whole breadth of the end-plate of the telescope, but this was far more than was required to measure the zenith distance of  $\gamma$  *Draconis* ; it was, however, made subservient to the measure of nearly the whole breadth in the following way :—On the fixed plate of the micrometer ten crosses of wires were fastened, as nearly as possible at equal distances, and on the moveable plate were fixed eleven wires at nearly the same distances. By means of the crosses on the fixed plate and the micrometer-movement, the interval from each wire on the moveable plate to the next wire was ascertained, in terms of the micrometer-screw, with great accuracy, and therefore the aggregate or distance of extreme wires was very well known. The intervals were also known in seconds of arc, by observations of the transits of stars when the instrument was turned to a position distant  $90^\circ$  in azimuth from its usual position. Thus the value of the screw, and the elements for making an observation in any part of the whole range available, were completely obtained. With this construction of micrometer, the *appui* of the micrometer-head was almost close to the bottom plate, and was perfectly firm. The eye-piece was carried by another sliding-plate, moving in grooves unconnected with the micrometer ; and it was moved by a separate

rack and pinion. It is presumed that in this form the Grand Micrometer was perfectly trustworthy.

In the use of this instrument it is evidently necessary to observe the same star successively in reversed positions of the instrument, the micrometer-head being on the north side in one observation and on the south side in the other observation; and the values of the Grand-Micrometer reading must be corrected in each observation by quantities depending on the two micrometer-readings of the plumb-line, in order to obtain for the two observations the angular distances of the star from definite (though imaginary) lines in space, equally inclined to the vertical, one on the north side, the other on the south side; and if this double operation be effected at one transit of the star, the result for the star's zenith distance is obtained without any computation of the star's corrections, and without any reliance on the permanence of the state of the instrument for more than a few minutes; but if the observation with micrometer-head north is made at the transit of one day, and that with micrometer-head south at the transit of another day, it is necessary to compute the change in the star's place (which can be done with undoubted accuracy), and also to be assured that no change has taken place in the relative position of the various parts of the instrument. For the details of the calculations of every kind applicable to these cases, it is best to refer to the Introductions to the volumes of *Greenwich Observations* from 1837.

For a considerable time, the instrument, not being furnished with two wires on the micrometer-plate at a distance nearly equal to double the star's zenith distance, could not be used for the double observation at a single transit (as the short duration in the field of view did not leave time enough for the numerous turns of the micrometer, with change of the observer's position, &c.), and it was therefore reversed after the completion of each day's observation. The results of the observations were not satisfactory, and the Astronomer Royal determined on so fitting up the instrument that it might be used for the double observation at a single transit.

The arrangements obviously necessary were, to fix on the micrometer-plate two wires at distances nearly equal to double the star's zenith distance, and to determine their interval accurately; and to provide stops for the reversion of the instrument, for the movement of the eye-piece, and for the movement of a part of the illuminating apparatus, which it was necessary to shift at each observation. But another change, the necessity for which seems to have been generally overlooked, then suggested itself. It is unsafe to consider any wire as absolutely straight: when it has once received a bend, even no more than the bend of passing round a reel, it retains a portion of that bend although stretched even to the breaking-point; and some of those curved parts of the wire may be under the microscopes by which the position of the plumb-line is checked. Now this is unimportant, provided that the bend is always turned in the same direction relatively to the instrument;

for then its only effect is to alter by a constant quantity the correction to the value of the Grand-Micrometer reading, which constant disappears on taking the difference of the two corrected Grand-Micrometer readings, upon which in fact the determined zenith distance depends. But if the position of the bend changes relatively to the instrument, the result is affected with error. Now it is extremely probable that the position of the bend will change, that is, that the plumb-line will turn relatively to the instrument, at every reversion, but more particularly so at rapid reversion; and some method must be adopted to prevent this turning.

For this purpose, the Astronomer Royal adopted the following construction:—On the side opposite to the eye-piece, and attached to the bottom plate of the telescope, a wooden box was carried out horizontally, its bottom being nearly as low as the foot plate, and its top at the level of the bottom plate of the tube; and upon the end of this box was planted a wooden plumb-wire tube, connected at its top with a frame attached to a higher part of the great tube (upon which frame the wooden plumb-wire tube and the horizontal box were, in fact, suspended). From the top of this wooden tube was suspended (with screw-adjustment for moving it to or from the principal plumb-line) a second plumb-line, 40 inches long, and distant from the principal plumb-line about 12 inches. The two plumb-lines supported in the horizontal box the two ends of a bar 12 inches long, and to this bar were attached one or two plumb-bobs. A little consideration of the theory of parallel forces will shew that, if the distance between the plumb-lines at the top and the bottom is the same (the criterion of which is, the distinctness of the principal plumb-line in the field of view of the lower microscope, whether the second plumb-line be used or not), the relative movements of the principal plumb-line for varying inclinations of the grand tube are the same as if the plumb-bob were immediately attached to it. At the same time, the turning of the wire is effectually prevented.

The instrument was used with this construction to the spring of 1848, when it was finally dismantled. The results of observation were more accordant than they were before introducing the last modification, but they were not superior to those derived from the mural circle. There can be no doubt that the remaining errors were greater than could be attributed to mere imperfection of observation, and that they must originate in some fault of the instrument. Generally speaking, the greatest errors coincided with the greatest irregularities in the readings of the lower plumb-line microscope. It has already been pointed out that the fixation of that microscope was not very firm, and the irregularities may have originated in this weakness. Or the great tube may have twisted sensibly in the reversion. Or the plumb-line may have been bound by spider-threads, from which it was to a certain degree set free by the movement of reversion (for it was found almost impossible to keep the wire-plate free from spider-threads, the uniform temperature and the constantly vertical position of the telescope being probably com-

fortable to those animals). Whatever the distinct cause might be, the Astronomer Royal considered that the instrument had failed, and that its failure was owing to the dependence on the plumb-line; and he expressed his hope that he might never again be compelled to use an instrument relying for its verification upon a plumb-line.

II. The applicability of a transit instrument in the prime vertical to the determination of latitude of place from assumed polar distance of the star, or *vice versa* (the polar distance of the star being greater than the co-latitude of the place), has long been known; but it seems to have attracted more particular attention since it was used by Struve in the determination of the difference of latitudes at the extremities of his arc of meridian parallel to the Baltic. Whatever be the construction of the transit instrument used, the proper method of observation is the following:—The error of level of the axis being ascertained, the instrument is directed to the star, while it is yet north of the eastern prime vertical, and the transit of the star is observed over each of the wires preceding the middle of the field; the position of the instrument being continually changed, so that the oblique transit is observed over the centre of each wire. When the star has passed the wire next before the middle, the instrument is reversed, and the passage of the star, now on the south side of the eastern prime vertical, is observed over the same wires as before, but in the opposite order. The error of level of the axis is then ascertained. Then, when the star is approaching the western prime vertical from the south, the instrument being still in its second position, the error of level of the axis is again ascertained; then the transit of the star is observed again over the same wires; before it passes the middle of the field, the instrument is reversed to its first position; then the transit of the star, now on the north side of the west prime vertical, is observed again over the same wires. Finally, the error of level of the axis is ascertained in this position.

The reduction of the observations is made in the following form, each wire being treated separately. The projection of each wire on the sky is a small circle whose pole is in the north point N of the horizon; and if  $\alpha$  be the angular distance of that wire from the line of collimation,  $90^\circ - \alpha$  will be the radius of the small circle when the star is seen on it north of the prime vertical, and  $90^\circ + \alpha$  when the star is south of the prime vertical. Form the spherical triangle NPS; let A be the hour-angle from the meridian, or the supplement of the angle at P;  $l$  the latitude of place;  $\delta$  the star's north polar distance. Then when the star is north of the prime vertical,

$$\cos(90^\circ - \alpha) = \cos l \cdot \cos \delta - \sin l \cdot \sin \delta \cdot \cos A_1$$

and when the star is south of the prime vertical,

$$\cos(90^\circ + \alpha) = \cos l \cdot \cos \delta - \sin l \cdot \sin \delta \cdot \cos A_2$$

Adding these two equations, we obtain

$$\cot l \cdot \cot \delta = \cos \frac{A_1 + A_2}{2} \cdot \cos \frac{A_1 - A_2}{2}$$

$A_1$  is half the interval between the first transit east and the second transit west, and  $A_2$  is half the interval between the second transit east and the first transit west, in both cases converted into arc. Thus by the observations on each wire we determine with great facility  $l$  from  $\delta$ , or  $\delta$  from  $l$ , without any knowledge of the distance of that wire from the line of collimation.

The mean error of level of the instrument may be applied to  $l$  before forming the logarithm of  $\cot l$  (supposing that it is the object of the observation to determine  $\delta$ ). Or a correction may be applied for it (which will be different for different stars) to the result obtained with a constant value of  $l$ . The latter is the course followed by Mr. Struve in reducing the observations of which I shall shortly speak.

The advantages peculiar to this observation are; that it is not affected by ordinary refraction; and that its scale, being one of time, is exact to a degree which is unapproachable in other ways. Bad, indeed, must the clock be of whose rate we are not certain within 1<sup>s</sup> per diem; therefore the uncertainty on our time-scale cannot practically amount to  $\frac{1}{80000}$  part of the whole, and that on the results of the observation, as depends on this cause, cannot amount to  $\frac{1}{30000}$  part of the whole. But the Astronomer Royal stated, as the result of his own experience, that an accuracy of  $\frac{1}{10000}$  in the determination of a micrometer-scale is almost more than can be hoped for. Other advantages which it possesses are common to other reversible instruments. Thus if there be a constant optical fault in the image of a star, produced by defects in the object-glass, that fault will produce opposite effects in the first and second positions of the instrument: if the pivots be mis-shapen, as if there be a hump upon one, yet if the form of the two Y's is similar, that hump will take the same bearing upon the east side of one Y in one observation as upon the west side of the other Y in another observation, and its effects will be annihilated in the result: if the pivots are unequal, the effects of the inequality are similarly annihilated. But to secure all these advantages, the two following instrumental points must be secured in the construction; the instrument must admit of having the level applied to it while the telescope is in the position of observation; and it must admit of being reversed with ease and rapidity. To the obtaining of these objects, the construction devised by Mr. Struve, and carried out by Messrs. Repsold, is particularly well adapted. This instrument is supported upon Y's carried by two stone pillars, about 6 feet high and 46 inches apart, from outside to outside; the *outside* face of the pillars being vertical, and the *inside* faces inclined to the vertical. The axis of the instrument has its bearings upon the two Y's; but the telescope (7 feet long) attached to this axis is *on the outside of one of the pillars*; a counterpoise at the other end of the axis being on the outside of the other pillar. Between the two pillars is the reversing apparatus, which also carries the ordinary counterpoises. It consists of a vertical shaft, sliding through holes in cross-bars which are fixed to the piers, and prevented by

a fillet upon it from turning until it is raised to a certain height; this vertical shaft carries a T head about 33 inches long, at the extremities of which are the lifting-forks, and also the fulcra of the ordinary counterpoises. The counterpoises act by means of levers to support a bar about 41 inches long, at the extremities of which are the friction-rollers, which at all times support the principal part of the weight of the instrument. The vertical shaft does, therefore, at all times support the fulcra-pressures of the counterpoises; and when the instrument is raised for reversion, by bringing up the vertical shaft so that the lifting-forks at the ends of the T head come in contact with the axis of the instrument, the only additional load which is put upon the vertical shaft is that pressure which was left as residual weight upon the Y's on the stone pillars, a pressure which, in the practice of the German astronomers, is very small. Two massive lever-counterpoises are therefore provided below, which act upwards under the foot of the shaft: and if these are adjusted to support the shaft when the instrument is not on the lifting-forks, they will also practically nearly support it when the instrument is on the lifting-forks: so that a very trifling effort of the hand is then necessary to raise the shaft with the instrument. This small effort is given through a winch, acting by means of bevel-gearing upon a large circular nut, which works on a screw-thread cut upon the shaft, and bears vertically upon one of the cross-bars: and thus by an exertion which appears almost fancifully small, the instrument is raised for reversion, is turned round (the telescope being placed horizontally), and is deposited in its new position. Of this reversing apparatus the Astronomer Royal spoke with great praise. Not only is the reversion effected with a rapidity and ease scarcely to be conceived, but also the counterpoises are acting in the same way, and the general strains upon the instrument are almost exactly the same, as when it is in ordinary use. The Astronomer Royal has borrowed this principle (although he has applied it in a different form), in the apparatus which he has adopted for raising the proposed transit-circle for the Royal Observatory, in order to give opportunity for the adjustment of its collimators.

The general form of the axis, being unencumbered by any telescope crossing it, is evidently well adapted to the application of the level at all times; a thing which is always important, but particularly necessary for the German instruments, which are frequently counterpoised almost to the last ounce, so that there is not in them the same security for the bearing of the pivots in their proper position as in our instruments, in which a far greater residual weight is left.

The instrument, therefore, and its auxiliary apparatus, are most admirably adapted to securing the two advantages, of easy reversion and application of the level in the position of observation, which are so desirable for this instrument. But these advantages, in the opinion of the Astronomer Royal, are very dearly bought by an entire abandonment of that mechanical firmness of connexion

between the telescope and the axis which is obviously necessary to make the observations trustworthy. The kind of firmness which is required is that which retains the telescope in a position at right angles to its axis; the same, in fact, as that required for a transit-instrument. We laugh at the transit-instruments of the last century, in which, while great pains were taken to secure length of axis between the bearings, the central connexion was left very weak; and we praise the modern transit-instruments, in which the central connexion has been made successively larger and larger, and not least so by the German artists; and of which a more admirable specimen cannot be cited than the Edinburgh transit-instrument, made by Messrs. Repsold, the constructors of Struve's prime-vertical instrument. Yet in this prime-vertical instrument, that important connexion is probably very far weaker than in any transit-instrument that ever was made. The whole support of the 7-feet telescope, upon the firmness of which support the value of the observations entirely depends, is a single perforated pivot, 4 inches in diameter, on one side of the telescope. It is true that the telescope is sustained, as regards the strain of its own weight upon the small pivot, by an internal concealed counterpoise (for no one who has mastered all the external counterpoises of a German instrument is therefore to suppose that he has possessed himself of all the applications of that principle in the interior of the instrument), whose fulcrum is in the perforated pivot, near the telescope, and whose weight is within the hollow case at the other end of the axis, which appears to the eye like a large counterpoise connected with the external axis. But this counterpoise, while it delivers the pivot from the ordinary strains to which it would be exposed from the weight of the telescope, does in no degree diminish the effect of what, perhaps, are really more formidable, the accidental strains produced by pressures on the ends of the telescope, or other accidental forces, or irregularities of forces, not taken into account in the construction of the instrument. For instance, if the Y's were slightly irregular, so that the principal bearing of the pivots on the northern Y was an inch nearer to the face of the pier than that on the southern Y (a thing which it would be nearly impossible to discover by examination), the difference in the bend of the axis in the two positions of the instrument would probably be so considerable that every result would be worthless.

In the opinion of the Astronomer Royal, the asserted consistency of results hitherto obtained with this instrument proves nothing. Although discordance proves the existence of some fault, accordance does not negative the existence of very great faults. The Astronomer Royal cited the expression of Bouguer, who, after much painful experience in the construction of zenith sectors, in different forms, for the measure of the Peruvian arc, came at last to the conclusion, that no agreement of results proved their truth, unless the logical correctness of construction of the instrument gave reason *à priori* for believing that the results would be good.

One defect to which this instrument is liable was pointed out

by Mr. Struve himself to the Astronomer Royal. It cannot be assumed that the temperatures of the external faces of the two piers are the same, and if they be not, the effects of their radiation upon the telescope-tube must be different.\*

The Astronomer Royal then remarked, that though perhaps the form of the ordinary transit-instrument would not give in their full extent the same facilities, yet the great importance of securing the admirable firmness and excellent connexions of the transit-instrument made it desirable for us to attempt to unite with them, as far as possible, the peculiar conveniences of Struve's instrument. In regard to the reversion, by a forked apparatus rising from the floor, there is no difficulty; the only difficulty is in the application of the level while the instrument is in the position of observation. There appears to be no valid reason prohibiting the use of one of the following constructions. The level-frame might consist of two bars extending from the pivot-forks towards the telescope, there interrupted in their straight course, and united by a large oval ring, through which the telescope could play; each bar must then carry a short spirit-level. Or it might consist of a parallelogrammic frame, strengthened in the middle by a ring through which the telescope could play, the two short sides being attached to the pivot-forks, and the two long sides carrying two long levels. But a different form of instrument may be suggested, allowing of the application of the ordinary single level at all times, and apparently embodying the conveniences of Struve's form, while it does not abandon the strength of the usual form. The transit-instrument may be made in the form of the letter T (the horizontal line of the T representing the axis of rotation), the object-glass of the telescope scarcely rising above the thick part of the axis. As the weight of the telescope is entirely on one side of the axis, it must be balanced by counterpoises carried by a very large fork; the stalk of the fork being within the telescope-tube, the two arms of the fork being in the axis of the transit, and resting within the pivots for a fulcrum, but projecting out beyond the pivots; and the two prongs of the fork projecting towards the object viewed by the telescope, and being loaded with the counterpoises at their ends.

If, however, we rely upon our transit taking the same bearing in the Y's after reversion, a very much simpler principle may be used, dispensing entirely with the level. It is only necessary, after having made the observations on the north side of the east prime vertical (as already described), to reverse the instrument and to observe on the south side of the east prime vertical by reflexion in a trough of quicksilver: then to reverse and observe on the south side of the west prime vertical by reflexion: then to reverse again, and to

\* The Prime Vertical Instrument of M. Struve, constructed by Repsold, is fully figured in Plates xxxii. xxxiii. of M. Struve's magnificent work, *Description de l'Observatoire de Poulkova*, Saint-Petersbourg, 1845. Drawings of the Greenwich Zenith Tube, and models of Struve's Prime Vertical Instrument and of the Reflex Zenith Tube, may be seen at the apartments of the Royal Astronomical Society.

observe, by direct vision, on the north side of the west prime vertical.

The Astronomer Royal expressed himself confident that in some of these ways the advantages of Struve's construction might be secured, with the additional guarantee for the goodness of the results, that they are obtained with an instrument of firm mechanical construction.

The Astronomer Royal then explained that his attention had been directed to these constructions by the necessity created by the present condition of astronomy for a few accurate observations, at whatever trouble obtained, of stars near the zenith. Struve's instrument is now employed on three stars only, and Mr. Struve is satisfied if of each of these stars he can obtain eight observations in a year. At Greenwich there is special need of observations of one star, namely  $\gamma$  *Draconis*, a star that may with propriety be considered as the birth-star of English astronomy. Unfortunately no instrument on the prime-vertical principle is applicable to this star, because it passes north of the zenith of Greenwich. The Astronomer Royal therefore has been compelled to endeavour to devise an instrument which shall be firm in its connexions, and shall also be applicable to the observations of stars on both sides of the zenith. The following is the construction which he proposes for this purpose.

III. The proposed Reflex Zenith Telescope is founded upon these considerations. If an object-glass be placed with its axis vertical; and if a pencil of light fall on it from a star near the zenith, and pass from the object-glass with its axis still inclined to the vertical, but with the rays of the pencil in a state of convergence; and if a trough of quicksilver be placed below it at a distance somewhat less than half the focal length of the object-glass; the pencil of light will then be reflected from the quicksilver with its axis still inclined in the same degree to the vertical, and with the rays still in the same state of convergence, and will again pass through the object-glass, and will form an image of the star at a very short distance above the object-glass, and at a distance from the axis of the object-glass depending on nothing but the star's zenith distance and the focal length of the object-glass. Although we cannot fix on the axis of the object-glass, yet we know that if the object-glass is turned through  $180^\circ$ , the image will now be formed at an equal distance from the axis of the object-glass, but in an opposite direction relatively to the frame of the object-glass; and therefore the distance between the two positions of the image, as measured by a micrometer attached to the frame of the object-glass, will be double the distance of either image from the axis of the object-glass, and will therefore be a measure of the star's zenith distance. The peculiar advantage of this construction is, that it requires no firmness of connexion except that of the micrometer with the frame of the object-glass. The mercury-trough may be totally unconnected with the rest of the instrument. The firmness of support of the object-glass is unimportant, for, however much the object-glass is pushed sideways (giving the same movement to the image of the

star), the micrometer is equally pushed sideways, and the measure of the image is not disturbed. The peculiar disadvantage is, that the light must be reflected from quicksilver, and must pass again through the object-glass, and must be transmitted through a four-glass eye-piece with a diagonal reflector, so that the whole loss of light will be considerable. But this disadvantage appears insignificant in comparison with the advantage.

Theoretically, the place of the image will be affected by a local fault in that part of the object-glass through which the rays pass the second time. But, practically, the existence of such a fault is unlikely: and its effect, if any existed, would be proportional to the distance of the image from the object-glass, and therefore small: and moreover it could be ascertained and measured by previous experiment on the object-glass. No injury therefore to the results, and no real inconvenience to the observations, would arise from such a fault.

The only risk to which this construction appears to be exposed is the following. If the object-glass with the micrometer attached be tilted, the place of the image of the star upon the micrometer will be disturbed by a small quantity, unless the plane of the micrometer be at one certain distance from the object-glass. It is therefore an important matter to determine what that certain distance will be. It is easily seen that if the plane of the micrometer pass through one of the points called *focal centres*, this condition is satisfied. For a ray from a vertical star passing through the focal centre (the object-glass being inclined), will be refracted in a parallel vertical direction to the quicksilver, and will then be reflected back from the quicksilver in the same line, and will by refraction be made to pass again through the same focal centre; and, supposing the distance of the quicksilver to be properly adjusted, so that the image of the star is formed on the micrometer, that image will be at the focal centre whatever be the inclination of the object-glass. The place of the focal centre may be determined by an apparatus, in which the object-glass is planted in a frame that admits of being slid in a direction perpendicular to its plane, the sliding-cell being upon a board which turns in its own plane on a pin; a beam of light is directed upon the lens through two narrow slits; and a telescope is placed on the opposite side of the object-glass to receive the light; when, by trial of sliding the frame, a position is so determined that, upon rotating the turning-board through a large angle, the position of the beam of light as seen in the telescope does not change, it is then certain that the focal centre is in the axis of rotation. If the micrometer can be conveniently fixed at this distance from the object-glass, the accidental inclination of the object-glass will be unimportant; if the micrometer is at any other distance, there will be a very small correction to the measures, depending on the inclination of the object-glass; and it will be proper that a small spirit-level be attached to the object-glass frame for the measure of the inclination. Perhaps in any case this addition will be prudent.

The adjustment to focal length will depend upon nothing but the distance between the object-glass and the quicksilver; and a power of altering this distance must be retained. It is proposed to do this by moving the tube, in which the object-glass turns, up or down by a rack-and-pinion motion, the tube and its load being as nearly as possible balanced by a lever-counterpoise. It is also proposed that a smaller quicksilver-trough, communicating with the larger, should carry a float, from which a light stalk should rise by the side of the object-glass frame; if this stalk be made of the same material as the micrometer, a scale upon the stalk will indicate the value of the micrometer-scale as corrected for thermal expansion, and as affected by any change of focal length.

Although such an instrument may be adapted to the observation of any stars which pass within a field of view expressed by the breadth of the object-glass, yet some conveniences of fixation are gained by limiting it to the one star  $\gamma$  *Draconis*. The following are the details of mounting proposed by the Astronomer Royal. The micrometer necessarily requires two metallic bars crossing the object-glass; and upon reversing the object-glass, with micrometer attached, the two bars will again occupy the same position in space. Consequently there will be no additional interruption of light if the support of the prism-reflector of the eye-piece be two bars in the vertical planes which pass through the micrometer bars, carried by crooked projections from the tube in which the object-glass turns (and therefore not reversed with the object-glass). And as the prism-reflector intercepts a small portion of the object-glass excentrically, a corresponding portion equally excentric on the opposite side must be intercepted by a small plate carried by the two bars, in order that the diffraction-disturbance of the star's image may be symmetrical. One lens of the eye-piece will be below the prism-reflector, and one close to its vertical, or nearly vertical, face (unless it be thought preferable to produce the effect of lenses, by grinding the faces of the prism-reflector to spherical forms): the remaining lenses of the eye-piece (namely, the field-glass and the eye-glass) will be fixed in a tube, entirely exterior to the object-glass and therefore causing no additional loss of light, carried by a crooked projection from the tube in which the object-glass turns. These crooked projections permit the micrometer-heads, and reversing-handle, &c. to pass, in the reversion of the object-glass.

Notwithstanding the great simplicity and compactness of the essential parts of this instrument, the Astronomer Royal thinks it desirable that it be so arranged that a double observation can be made at each transit of the star. It is necessary for this purpose that two wires be fixed in the micrometer plate, at an interval corresponding nearly to the double zenith distance of the star. By fixing temporarily in the immediate field of view of the eye-piece a cross of wires, or by planting a microscope for the occasion above the micrometer frame, the interval between these two wires may be found very accurately in terms of the revolutions of the micrometer; and by fixing other wires on the micrometer plate at intervals as

nearly as possible equal to that interval, and by using a series of microscopes fixed for the occasion, the micrometer-scale-intervals between all these wires may be very accurately found. And, by turning the object-glass and attached micrometer to a position  $90^{\circ}$  distant from either of the positions of observation, and observing the transits of zenithal stars over all the wires, the intervals in arc may be found. The combination of these will give the best possible information on the value of the micrometer-scale, and on the intervals of the wires.

A simple micrometer might be used for the observation; it would, however, have these disadvantages, that the micrometer must be read between the two observations, and that the observer could not use the same hand in the two actions upon the micrometer head. The Astronomer Royal proposes a more complex micrometer, in which the micrometer B, to which the bisection-wires are attached, is carried by and has its screw-*appui* in a micrometer A; and the micrometer A has its screw-*appui* in the cell of the object-glass. There is no difficulty in so arranging this that the movement of micrometer A shall not tend to disturb the relative place of micrometer B, and that the movement of micrometer B shall not tend to disturb the absolute place of micrometer A, (A and B standing in exactly the same relation as the tangent-screw of a mural circle, and the micrometer in its telescope): and then the observation may be conducted in this manner. One wire being very nearly in the position for bisecting the star, A will be read, and the bisection will be completed by B. Without waiting to read the micrometer head, the object-glass, &c. will be reversed, and the second bisection will be completed by A. Then A and B will be read. It will be proper sometimes to effect the reversion in the opposite order: and for this purpose, using the same hand on the micrometer, B must be read before beginning, and the first bisection must be completed by A, and after reversion the second bisection must be completed by B. In either case the complete double observation may be obtained with great rapidity, but without the smallest hurry.

The Astronomer Royal expressed his belief that an instrument thus constructed might be expected usually to give results accurate to one-tenth of a second of arc.

The Astronomer Royal then stated that, before attaching any name to this construction, he had requested the assistance of the Master of Trinity College, Cambridge, whose authority in a philosophical question of this kind is undisputed. Doctor Whewell has fixed on the name "*THE REFLEX ZENITH TELESCOPE*," a name which appears to express with singular accuracy the peculiarities of its construction, and which the Astronomer Royal hoped would be universally adopted.

## METIS.

*Ephemeris at Greenwich Mean Midnight. By Mr. Graham.*

1840.				N.P.D.				1840.				N.P.D.			
R.A.				R.A.				R.A.				R.A.			
July 12	22	44	38.70	106	29	44.8		Aug. 21	22	21	8.20	110	27	37.3	
13	44	33.65		33	53.7			22	20	10.11		33	35.5		
14	44	26.91		38	11.7			23	19	11.73		39	26.8		
15	44	18.46		42	38.7			24	18	13.13		45	10.7		
16	44	8.30		47	14.5			25	17	14.38		50	46.8		
17	43	56.44		51	59.1			26	16	15.56	110	56	14.6		
18	43	42.85	106	56	52.1			27	15	16.77	111	1	33.8		
19	43	27.56	107	1	53.3			28	14	18.06		6	43.9		
20	43	10.55		7	2.6			29	13	19.53		11	44.5		
21	42	51.84		12	19.7			30	12	21.24		16	35.4		
22	42	31.44		17	44.3			31	11	23.28		21	16.2		
23	42	9.34		23	16.2			Sept. 1	10	25.71		25	46.5		
24	41	45.57		28	55.1			2	9	28.61		30	6.2		
25	41	20.13		34	40.5			3	8	32.05		34	14.8		
26	40	53.05		40	32.3			4	7	36.12		38	12.3		
27	40	24.33		46	30.0			5	6	40.86		41	58.2		
28	39	54.00		52	33.6			6	5	46.36		45	32.5		
29	39	22.09	107	58	42.3			7	4	52.70		48	54.9		
30	38	48.61	108	4	55.9			8	3	59.93		52	5.2		
31	38	13.59		11	14.0			9	3	8.13		55	3.3		
Aug. 1	37	37.06		17	36.2			10	2	17.36	111	57	49.0		
2	36	59.04		24	2.2			11	1	27.68	112	0	22.1		
3	36	19.56		30	31.5			12	22	0 39.18		2	42.6		
4	35	38.65		37	3.6			13	21	59 51.91		4	50.4		
5	34	56.34		43	38.2			14	59	5.93		6	45.3		
6	34	12.68		50	14.8			15	58	21.28		8	27.4		
7	33	27.70	108	56	52.9			16	57	38.03		9	56.6		
8	32	41.42	109	3	32.0			17	56	56.24		11	12.8		
9	31	53.91		10	11.7			18	56	15.96		12	16.1		
10	31	5.22		16	51.3			19	55	37.22		13	6.6		
11	30	15.40		23	30.5			20	55	0.07		13	44.2		
12	29	24.51		30	8.7			21	54	24.55		14	9.0		
13	28	32.59		36	45.3			22	53	50.70		14	21.1		
14	27	39.70		43	19.9			23	53	18.55		14	20.6		
15	26	45.92		49	51.8			24	52	48.13		14	7.6		
16	25	51.29	109	56	20.6			25	52	19.47		13	42.1		
17	24	55.90	110	2	45.7			26	51	52.58		13	4.3		
18	23	59.83		9	6.4			27	51	27.48		12	14.5		
19	23	3.14		15	22.2			28	51	4.18		11	12.7		
Aug. 20	22	22	5.91	110	21	32.6		Sept. 29	21	50	42.71	112	9	59.1	

1849.				R.A.				N.P.D.				1849.				R.A.				N.P.D.																																											
Sept. 30				h	m	s		°				°				h				m	s		°				°																																				
				21	50	23	08	112				8				33				7				Oct. 16				21	49	21	62	111				21				23				2																			
Oct. 1				50				5				29				6				56				8				17				49				33				46				17				2				1											
2				49				49				35				5				8				6				18				49				47				09				12				32				0											
3				49				35				27				3				9				2				19				50				2				50				7				53				0											
4				49				23				05				112				0				58				8				20				50				19				67				111				3				5				2			
5				49				12				70				111				58				37				3				21				50				38				59				110				58				8				9			
6				49				4				22				56				5				0				22				50				59				22				53				4				1											
7				48				57				60				53				22				2				23				51				21				56				47				51				0											
8				48				52				85				50				29				0				24				51				45				57				42				29				8											
9				48				49				96				47				25				4				25				52				11				25				37				0				5											
10				48				48				93				44				11				6				26				52				38				56				31				23				3											
11				48				49				77				40				47				8				27				53				7				46				25				38				4											
12				48				52				46				37				14				1				28				53				37				95				19				45				9											
13				48				57				00				33				30				7				29				54				10				00				13				45				8											
14				49				3				38				29				37				6				30				54				43				58				7				38				4											
Oct. 15				21	49	11	59	111				25				35				0				Oct. 31				21	55	18	67	110				1				23				7																			

## FLORA.

## HAMBURG.

(M. Rümker.)

1840.	Hamburg M.T.			R.A.			Dec.			
	h	m	s	°	'	"	°	'	"	
Feb. 17	15	19	30.2	220	17	0.3	-7	58	27.2	Equatoreal.
24	16	53	32.1	220	55	33.1		49	44.9	—
27	15	27	40.0	221	5	47.3		43	55.9	—
March 3	16	13	42.6		13	57.9		34	17.2	—
5	17	7	13.5	221	15	37.1	7	28	48.0	—
19	12	38	38.7	220	44	34.1	6	35	7.4	—
31	10	59	0.0	219	2	39.2	5	38	11.7	—
May 3	11	18	39.5	211	22	15.4	2	50	33.0	Mer. Circle.
4		13	45.9	211	7	46.9		46	58.9	—
5	11	8	52.8	210	53	26.4		43	31.2	—
12	10	35	4.1	209	18	51.5		23	28.2	—
18	10	6	45.6	208	7	56.0		12	52.3	—
20	9	57	29.7	207	46	54.0		10	58.0	—
21		52	53.8		36	48.7		10	11.8	—
22		48	19.3		27	5.9		9	46.4	—
24		39	14.5	207	8	50.4		8	59.9	—
26	9	30	13.3	206	51	30.0		9	23.8	—
30	10	52	37.6	206	22	36.7		11	45.5	Equatoreal.
June 11	11	43	13.6	205	33	37.3		35	45.9	—
13	11	31	16.1		31	3.7		41	38.2	—
14	11	28	26.5		30	22.5		45	10.1	—
15	11	12	50.0	205	30	6.7	-2	48	34.0	—

## LIVERPOOL.

Equatoreal.

(Mr. Hartnup.)

1840.	Greenwich M.T.			R.A.			N.P.D.			Comp <sup>d</sup> —Obs <sup>d</sup> .		Stars B.A.C.
	h	m	s	h	m	s	°	'	"	+ "	+ "	
May 28	12	26	50.1	13	46	22.64	92	10	4.4	+ 1.36	+ 10.7	4604, 4665
June 5	12	1	47.4		43	22.40		20	44.7	1.64	9.0	4547, 4665
6	11	41	10.6		43	7.13		22	51.1	1.73	6.4	— —
7	11	45	14.6		42	53.43		25	6.3	1.57	6.9	— —
9	11	52	11.4		42	30.42		30	4.5	1.69	8.6	— —
10	11	40	8.1		42	21.66		32	47.9	1.46	7.6	— —
13	11	28	1.3		42	3.85		41	51.2	1.60	8.6	— —
17	11	44	44.3		42	2.18		56	3.3	1.48	10.2	— —
18	10	50	56.9	13	42	5.38	92	59	52.1	+ 1.54	+ 6.4	— —

"The observed places are corrected for refraction and parallax. The computed places were deduced from Dr. Brünnow's Ephemeris, published in the *Monthly Notice*, vol. ix. No. 7. The places of the stars are taken from the catalogue cited. The right ascension of 4604 appears, by the other stars with which *Flora* is compared, to be about 0.5 too great. The correction to the Ephemeris in right ascension from 4665 alone on May 28 = +1.62.

"The results on June 6th and 18th are each deduced from one observed transit over five wires and the readings of two microscopes; on all the other days the observation was repeated, and the mean of the two taken."

## IRIS.

HAMBURG.	Meridian Circle.		(M. Rümker.)
1840.	Hamburg M.T.	R.A.	Dec.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
Feb. 11	12 32 13.3	149 58 31.9	+ 3 9 17.4
17	12 2 30.1	148 26 20.0	3 37 29.3
23	11 32 57.6	146 56 49.3	4 8 24.2
24	28 4.6	42 28.3	13 37.8
27	11 13 30.2	146 0 42.7	4 29 40.0
March 6	10 40 8.6	144 32 54.5	5 6 44.4
8	30 48.2	10 42.7	17 1.0
9	26 10.2	144 0 13.6	22 8.4
12	12 24.7	143 30 42.4	36 55.7
13	7 53.0	21 44.2	41 43.6
14	10 3 22.8	143 13 8.0	5 46 30.6
19	9 41 15.6	142 36 3.4	6 8 55.3
30	8 55 4.7	141 51 56.6	49 2.8
31	51 3.2	50 29.8	6 52 3.0
April 5	31 19.7	49 33.4	7 4 58.9
6	8 27 28.2	141 50 37.4	+ 7 7 9.6

## HEBE.

HAMBURG.			(M. Rümker.)
1840.	Hamburg M.T.	R.A.	Dec.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
Feb. 11	8 9 36.4	84 8 29.4	+ 11 54 56.7
17	7 48 4.6	39 29.7	Mer. Circle.
18	44 34.7	84 46 2.0	13 1 9.1
21	34 16.3	85 8 24.5	23 22.6
23	7 27 32.1	85 25 21.7	13 46 5.1
March 6	6 52 13.1	87 24 40.5	15 16 47.8
14	8 44 12.9	89 17 37.6	16 15 43.2
19	9 51 2.7	90 37 44.3	+ 16 48 59.0
			Equatorial.

## NEPTUNE.

*Ephemeris for Greenwich Mean Noon (Encke's Jahrbuch 1851).*

	R.A.	N.P.D.		R.A.	N.P.D.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>		<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
July 9	22 26 45.30	100 30 36.8	Oct. 7	22 18 35.79	101 18 30.0
19	26 4.24	34 51.7	17	17 57.98	21 58.8
29	25 15.01	39 51.7	27	17 30.87	24 25.0
Aug. 8	24 19.42	45 27.4	Nov. 6	17 15.65	25 42.6
18	23 19.46	51 21.1	16	17 13.10	25 47.7
28	22 17.45	100 57 24.1	26	17 23.69	24 38.3
Sept. 7	21 15.74	101 3 21.7	Dec. 6	17 47.22	22 15.5
17	20 16.68	9 0.6	16	18 23.45	18 42.7
27	22 19 22.64	101 14 7.2	26	19 11.38	14 2.7

Adams' Elements: Hor. Par. = 0".3.

## HYGEIA.

## NAPLES.\*

	Naples M.T.	R.A.	Dec.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
1849. April 14	377.1	182 57 57	-7 28 18
	17.5854	182 28 11	7 13 10
	22.3840	181 49 20	6 52 6
	23.3563	41 38	47 31
	25.4096	27 19	39 21
	26.3598	20 56	35 37
	27.4071	14 38	31 48
	29.3745	181 3 14	24 26
May 1	382.3	180 53 1	17 9
	5.4768	35 57	6 3 57
	7.3890	30 3	5 58 40
	8.2877	27 21	55 49
	13.4160	18 53	45 13
	15.3961	17 57	40 24
	16.3988	180 18 2	-5 39 3

## PADUA.\*

(Professor Santini.)

	Padua M.T.	R.A.	Dec.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
May 27	10 38 41	180 39 50	-5 29 42
29	10 3 4	180 47 47	-5 29 12

"It is not quite certain that the planet was observed at Padua, but it appears probable that both R.A. and Declination of May 27 and R.A. of May 29 are those of the planet."

## LIVERPOOL.

## Equatoreal.

(Mr. Hartnup.)

	Greenwich M.T.	R.A.	N.P.D.	Star B.A.C.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	
1849. June 5	10 30 44.6	12 5 45.10	95 34 51.2	4172
6	11 5 14.7	12 6 13.13	95 36 14.2	4080
7	10 35 37.5	12 6 40.12	95 37 27.1	—
9	10 40 45.3	12 7 39.07	95 40 32.8	—
10	10 45 8.5	12 8 10.09	95 42 16.9	—
13	10 36 31.8	12 9 49.27	95 48 9.2	—
17	10 50 42.1	12 12 16.45	95 57 40.0	—
18	10 24 53.2	12 12 54.98	96 0 13.4	—

"The observations are corrected for refraction and parallax. The horizontal parallax was taken from Mr. Graham's Ephemeris. The places of the stars of comparison are taken from the catalogue cited.

"The planet appeared to me a little, but not much, fainter than *Flora*. I was favoured by Professor Schumacher with an account of its discovery as early as the 14th May, and subsequently the Astronomer Royal supplied me with an ephemeris by Mr. Breen; but the weather was so unfavourable here that I did not succeed in finding the planet till the 5th June."

\* Communicated by Professors Schumacher and Santini to the President. M. de Gasparis referred the naming of his new planet to M. Capocci, who has called it *Hygeia*.

## SOUTH VILLA.

(MM. Bishop and Hind.)

	Greenwich M.T.	R.A.	N.P.D.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
May 27	9 51 45	180 39 40.5	95 29 50.4
June 1	10 32 53	181 2 35.9	31 25.1
2	9 58 19	181 7 52.2	32 6.1
10	9 41 10	182 1 49.7	42 2.8
13	9 53 1	182 26 43.4	95 47 54.6

## HAMBURG.

Equatoreal.

(M. Rümker.)

	Hamburg M.T.	R.A.	Dec.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
1849. May 22	10 28 35.5	180 24 44.4	-5 32 4.4
24	10 38 10.4	29 48.3	30 48.6
26	10 36 53.3	36 0.9	30 9.8
28	10 30 49.8	180 43 39.7	-5 30 4.5

## GOUJON'S COMET.

*Ephemeris.* By Mr. Pogson.

For Greenwich Mean Midnight.

	R.A.	Dec.		R.A.	Dec.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>		<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
May 28	11 24 49.7	+60 49 29	June 20	12 11 58.0	+69 13 54
29	26 20.9	61 22 53	21	14 40.5	27 8
30	27 54.7	61 54 46	22	17 26.8	39 51
31	29 31.1	62 25 16	23	20 16.9	69 52 5
June 1	31 10.2	62 54 28	24	23 10.9	70 3 50
2	32 52.1	63 22 27	25	26 8.8	15 7
3	34 36.7	63 49 16	26	29 10.7	25 57
4	36 24.1	64 15 0	27	32 16.6	36 19
5	38 14.3	64 39 42	28	35 26.5	46 15
6	40 7.1	65 3 25	29	38 40.6	70 55 45
7	42 2.8	26 11	30	41 59.0	71 4 49
8	44 1.8	65 48 4	July 1	45 21.5	13 28
9	46 4.0	66 9 5	2	48 48.2	21 42
10	48 8.9	29 18	3	52 19.0	29 30
11	50 16.8	66 48 45	4	55 54.1	36 54
12	52 27.9	67 7 28	5	12 59 33.3	43 52
13	54 42.2	25 28	6	13 3 16.7	50 26
14	56 59.8	42 48	7	7 4.2	71 56 34
15	11 59 20.7	67 59 28	8	10 55.9	72 2 18
16	12 1 45.1	68 15 31	9	14 51.7	7 36
17	4 12.9	30 58	10	18 51.8	12 30
18	6 44.3	68 45 50	11	22 56.0	16 59
June 19	9 19.3	+69 0 8	July 12	13 27 4.4	+72 21 4

	497 <sup>h</sup> x Δ m	Hor. Par. s		497 <sup>h</sup> x Δ m	Hor. Par. s		497 <sup>h</sup> x Δ m	Hor. Par. s
May 28	6 40	10 <sup>h</sup> 68	June 13	8 39	8 <sup>h</sup> 24	June 29	10 16	6 <sup>h</sup> 94
June 1	7 11	9 <sup>h</sup> 90		17 9 5	7 <sup>h</sup> 84	July 3	10 36	6 <sup>h</sup> 71
	5 7 42	9 <sup>h</sup> 25		21 9 30	7 <sup>h</sup> 49		7 10 55	6 <sup>h</sup> 52
	9 8 11	8 <sup>h</sup> 71		25 9 54	7 <sup>h</sup> 19		11 11 13	6 <sup>h</sup> 35

"The foregoing places are reckoned from the true equinox of the day. The elements employed are those of M. D'Arrest, as given in the last *Monthly Notice* of the Society," page 161.

## LIVERPOOL.

## Equatoreal.

(Mr. Hartnup.)

	Greenwich M.T.			R.A.			Log $\frac{p}{P}$	N.P.D.			Log $\frac{q}{P}$	Star B.A.C.
1840.	h	m	s	h	m	s		°	'	"		
May 23	12	17	57.8	11	18	3'30	+8.853	32	13	49.5	-9.447	3959
28	13	56	38.5	11	25	7.21	8.905	28	58	57.8	9.689	—
June 5	13	19	16.0	11	38	35.60	8.970	25	9	24.3	9.587	4036
9	13	15	25.0	11	46	28.69	8.992	23	39	53.7	9.590	4074
13	12	25	42.5	11	55	8.00	9.018	22	23	45.3	9.537	4122
19	11	58	56.5	12	9	46.73	9.044	20	49	34.3	9.313	4222
23	12	4	34.2	12	20	50.32	+9.065	19	57	28.0	-9.347	—

"The observations are corrected for refraction. The corrections to be applied for parallax in time and arc are represented by  $p$  and  $q$ .  $P$  is the equatoreal horizontal parallax.

"The observations were all made with illuminated wires in a dark field. The comet was bright enough to admit of the wires being illuminated in this way, even when the moon was full and near the meridian.

"The places of the stars are taken from the catalogue cited. The positions of all, except 4222, depend wholly on Groombridge.

"On the 23d June, the comet had the appearance of a faint nebulous star. The nucleus was decidedly stellar, and about equal to a star of the twelfth or thirteenth magnitude. Power 134 was used for all the observations."

## STARFIELD.

## 20-foot Equatoreal.

(Mr. Lassell.)

	Starfield Sid. Time.			R.A.	Starfield Sid. Time.			N.P.D.
1840.	<sup>h</sup> h	<sup>m</sup> m	<sup>s</sup> s	Star—Comet.	<sup>h</sup> h	<sup>m</sup> m	<sup>s</sup> s	Star—Comet.
June 23	18	48	6 <sup>s</sup> 1	2 31 <sup>s</sup> 07	18	47	36 <sup>s</sup> 2	27 <sup>s</sup> 20
	19	5	6 <sup>s</sup> 9	2 28 <sup>s</sup> 40	19	4	36 <sup>s</sup> 9	38 <sup>s</sup> 03
	19	19	22 <sup>s</sup> 6	2 26 <sup>s</sup> 67	19	18	52 <sup>s</sup> 9	43 <sup>s</sup> 95

Star of comparison, B.A.C. 4222.

"Magnifying power 219, applied to a micrometer of my own construction. The comet had a very minute stellar disc, and was easily observed. No illumination used, the twilight rendering the bars of the micrometer sufficiently visible."

## SOUTH VILLA.

(MM. Bishop and Hind.)

	Greenwich M.T.			R.A.	N.P.D.		
	<sup>h</sup> h	<sup>m</sup> m	<sup>s</sup> s	<sup>h</sup> h	<sup>m</sup> m	<sup>s</sup> s	<sup>s</sup> s
May 23	10	0	58 <sup>s</sup>	169	29	28 <sup>s</sup> 4	32 18 9 <sup>s</sup> 5
June 11	10	15	30 <sup>s</sup>	177	36	57 <sup>s</sup> 3	23 2 29 <sup>s</sup> 8

HAMBURG.	Equatoreal.		(M. C. & G. Rümker.)	
1840.	Hamburg M.T.	R.A.	Dec.	
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	
April 20	8 52 9.8	166 8 36.7	— 9 49 0.5	C. R.
26	11 48 59.1	170 30 43.1	59 45 28.9	G. R.
28	11 38 36.5	171 13 42.9	60 56 49.1	—
June 11	12 21 5.4	177 38 35.4	66 58 39.4	—
13	12 38 44.9	178 46 27.7	67 35 32.8	—
14	12 35 57.5	179 21 0.9	67 53 8.5	—
15	12 27 21.3	179 56 3.2	68 9 30.0	—
17	11 35 2.4	181 8 46.2	+68 40 56.0	—

HAVERHILL.	(W. W. Boreham.)			
1840.	Greenwich M.T.	R.A.	N.P.D.	Star of Comp.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	
May 3	11 7 47	11 2 16.95	59 23 9.9	H.C. 21331
7	10 28 53	3 45.10	51 7 59.5	— 21364
13	9 47 41	7 34.11	41 58 58.7	Arg. Z. 178: 73
15	11 14 59	9 20.66	39 31 51	B.A.C. 3846
22	11 2 16	16 44.68	33 1 45	Arg. Z. 100: 22
23	11 0 42	17 59.54	32 16 49.4	Arg. Z. 199: 19
27	10 46 44	11 23 17.07	29 38 0.2	Arg. Z. 184: 37

"The first two observations are corrected for refraction and parallax; in the others these corrections are neglected.

"The absence of any stellar nucleus in this comet renders it difficult to observe."

### SCHWEITZER'S COMET.

HAMBURG.	Equatoreal.		(M. Rümker.)	
1840.	Hamburg M.T.	R.A.	Dec.	
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	
May 3	9 46 9.2	145 7 42.5	— 11 47 18.6	

*On the Orbits of Double Stars.* By M. Yvon Villarceau.

(Third Notice.)

ξ *Ursæ Majoris*.

"M. Savory, who first attempted the problem of determining the elliptic motion of double stars, applied, as is known, his formulæ to the binary system ξ *Ursæ Majoris*.

"M. Savory has only given his result as an example of the computation, pointing out the probability of a great difference between his elements and the true elements. The observations at his disposal only extended to 1827, and it is remarkable that his determinations do not differ more widely from those which are deduced

from the observations of 20 additional years. M. Savory's greatest difficulties must have occurred in passing from the observed positions to those which he has substituted, which are the base of his calculations. It is to be regretted that the learned Academician has not thought it necessary to enter into the details.

"Mr. Mädler has since occupied himself with the same star, using observations which extend to 1841. The elements which he has deduced do not differ considerably from those which I have the honour to present.

"The system of  $\xi$  *Ursæ Majoris* consists of two stars. These are, according to M. Struve, of the 4th and 5th mag. respectively. M. M. Herschel and South estimate them of the 6th and  $6\frac{1}{2}$  mag.

"The earliest observation of  $\xi$  *Ursæ Majoris* was made by Sir W. Herschel in 1781·97; he reobserved it again in 1802 and 1804. The last two observations are only equivalent to one distinct position in regard to the determination of elements. From 1819 to the present time numerous observations have been made by different astronomers, and particularly by M. M. Struve and Sir John Herschel. The series is almost continuous.

"I have obtained a first approximation to the elements by the new method which I presented to the Academy at its sitting on March 26. For this purpose and to simplify the computations, I united in six groups, as well for the angles of position as for the distances, 20 observations of position and 17 of distance, extending from 1819 to 1847. A preliminary graphical construction had shewn me the possibility of grouping the observations without notable error. I have found, as I had previously expected, that these observations alone, though embracing a period of 28 years and containing an angular displacement of  $152^\circ$ , were not by themselves sufficient even for an approximate value of the elements. For example, one could satisfy them within the limit of moderate errors with a periodic time of 166 years, and even longer; or with one of about 61·5 years. Besides this, the problem then becomes doubly indeterminate, as two of the constants on which the elements depend may receive independent variations. The ancient observations are necessary, and sufficient to destroy the double indetermination: comparing that of 1781·97 with the modern observations, we obtain at once 62 years as an approximate value of the periodic time. From this the mean motion is deduced, whence results an equation of condition between the two indeterminate constants, from which one of these may readily be expressed in a function of the other. In this manner only one arbitrary quantity is left, the value of which is fixed by the condition of satisfying a single angle of position, the result of the two observations of 1802 and 1804. The degree of approximation at which I have thus arrived is tolerably satisfactory, notwithstanding the employment of somewhat indifferent observations from 1819 to 1823, the effect of which is to alter the calculated angles of position for that interval.\*

\* Many of these observations were made with meridian instruments.

"If my only object had been that of obtaining an orbit of  $\xi$  Ursæ Majoris, this first determination would have been sufficient. But it is important for the discussion of observations, and the perfecting of micrometrical measurements to which this discussion may lead, to obtain the highest possible degree of precision. I have therefore set myself to correct my first elements, by employing all the known angles of position (two alone excepted) and all the measures of distance made by M. M. Struve since 1825. I have also employed one observation of 1828, which M. Otto Struve has had the kindness to send me, and which I did not receive till after the first portion of my work was completed. By means of the errors resulting from a comparison of observations with the approximate elements, I have formed eight groups for the angles of position and five for the distances. From these I have deduced *normal* positions, which I have substituted for the observations. The elements corrected by using these *normal* positions, and compared with the observations, have given for each of the above groups errors, the means of which coincide very nearly with the errors resulting from a comparison with the *normal* places. This proves that I should not sensibly have obtained greater precision by employing all the observations than by employing the *normal* positions.

"I present here the approximate and corrected elements, and also a comparison of each with the observations: —

Elements of the relative Orbit of  $\xi$  Ursæ Majoris.

	1826.0	R.A. = $11^h 8^m.8$	N.P.D. $57^\circ 30'$ , 4 and 5 mag.
	First Approximation.		Second Approximation.
True Perihelion Passage...	1817 <sup>y</sup> .436	& 1879 <sup>y</sup> .436	1816 <sup>y</sup> .859 & 1878 <sup>y</sup> .435
Mean Annual Motion.....	$5^{\circ} 80' 64''$		$5^{\circ} 84' 64''$
Angle (sin = eccentricity)...	$26^\circ 2'$		$25^\circ 33' 7''$
Long. Asc. Node, reckoned from the apparent North in 1834.4 towards the East	276 5'5		275 50'0
Dist. of Per. to Asc. Node..	311 5'3		308 57'2
Inclination .....	$\pm 128^\circ 22' 6''$		$\pm 127^\circ 11' 4''$
Semi-axis major (observa- tions of M. M. Struve).... }	$2'' 40' 82''$		$2'' 43' 89''$

Hence I deduce,

	years.	years.
Periodic Time .....	62.0	61.576
Excentricity .....	0.43891	0.43148

For the apparent orbit I find,

	Date.	Position.	Dist.
Greatest apparent Aphelion..	1795 <sup>y</sup> .111 & 1856 <sup>y</sup> .687	112 46'4	3'0538
Least — —	1824.461 1886.037	247 15'2	1'7187
Least apparent Perihelion...	1814.760 1876.336	356 12'5	0'8891
Greatest — —	1828.881 1890.457	218 25'8	1'6924

"The angles of position in this table are reckoned from the same origin as the ascending node.

*Comparison of the El*

Date.	Angles of Position.	OBSERVATIONS.			Observer
		Distance.	Magnifying Power.	Number of Days.	
1781.97	143 47			1	W. Herschel
1802.09	97 31			1	—
1804.08	92 38			1	—
1819.10	284 33			2	W. Struve.
1820.13	276 21			3	—
1821.78	264 42			3	—
1823.29	258 27			4	Herschel & South.
1825.22	242 32				
1826.20	238 45	1.747	600	3	W. Struve.
1826.20	238 17				South.
1827.27	228 16	1.715	570	4	W. Struve.
1828.37	224 1				J. Herschel.
1829.02	219 0				—
1829.35	213 35	1.671	583	7	W. Struve.
1830.58	206 18				J. Herschel.
1831.08	201 32				Beasel.
1831.25	201 7				J. Herschel.
1831.34	201 55				Dawes.
1831.44	203 49	1.706	600	5	W. Struve.
1832.16	198 10				J. Herschel.
1832.27	196 43				Dawes.
1832.41	195 56	1.750	600	5	W. Struve.
1833.14	189 58				J. Herschel.
1833.23	189 50				Dawes.
1833.84	188 25	1.762	1000	5	W. Struve.
1835.41	180 11	1.764	920	5	—
1836.44	171 12	1.972	800	4	—
1837.47	165 19	1.927		3	Struve, <i>Add</i>
1837.53	167 23				Encke.
1838.43	160 23	2.260		9	Struve, <i>Add</i>
1839.47	157 58				Galle.
1840.25	152 14				Kaiser.
1840.40	155 24	2.286	858	7	W. & O. Stru
1841.29	150 12				Mädler.
1841.402	152 8	2.282	858	6	O. Struve.
1842.40	148 47	2.410	858	4	—
1844.788	140 52	2.526	858	5	—
1846.365	138 49	2.620	858	4	—
1847.407	131 50	2.700	858	3	—
1848.406	128 43	2.752	858	5	—

that a nodal passage occurred on 1847, Oct. 2<sup>d</sup>.745, Greenwich Mean Time, and that the period (as indicated by the whole series of observations) is 5<sup>d</sup>.8750, the angles of position observed by Mr. Lassell and Professor Bond are well represented; but the measures of M. Otto Struve present a marked disagreement in angle, the mean error of calculation, according to eleven observations by this astronomer, being +6°.6: the individual errors are uniformly in excess. I can discover no mistake in my computations, and can only suppose that we have here another instance of a constant personal equation affecting the measured angles of position, similar to that which has been pointed out by Sir John Herschel in Professor Struve's observations of  $\gamma$  *Virginis*, and in Professor Mädler's more recent measures of the same star.

"The distances present a similar anomaly. Treating the observations at the three observatories separately, I find,—

The Apparent Mean Distance of Satellite from Planet's centre,	
At Distance = 30°.0, by Professor Bond's observations .....	16°.102
— by Mr. Lassell's observations .....	16°.423
— by M. Otto Struve's observations .....	18°.060

"The values inferred from the English and American measures agree as nearly as can be expected from the number of observations employed. The Pulkova distance is nearly two seconds greater than this mean, a quantity sufficient to produce a very material alteration in the mass of the planet as determined by observations of the satellite.

"The cause of these differences may, perhaps, be explained hereafter; but the knowledge that such constant discordances may exist between different observers will probably tend to throw much uncertainty over the values of the planet's mass deduced from actual observation.

"If we assign to each of the above results its proper weight depending on the number of measures on which it is founded, we shall have for the radius of the satellite's orbit at the same unit of distance,

$$16''\cdot748,$$

and supposing the periodic time 5<sup>d</sup>.8750, which must be close upon the truth, the mass of *Neptune* comes out

$$\frac{1}{17900}.$$

"The distance of the satellite from the planet's centre appears to be 232'000 miles."

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*On the first Comet of Brorsen, 1846.* By Mr. Hind.

"In the *Monthly Notice* of this Society for November 1846, I pointed out the remarkably close approach of the periodical comet

of Brorsen to the planet *Jupiter* in May 1842; the result there given being founded upon Dr. Brünnow's approximate elements. Having since calculated an orbit from the whole extent of observation, I recomputed the distances between the planet and comet between May 0 and June 9, and the results seem to establish the fact of a very near approach, though not quite so close as Dr. Brünnow's elements had indicated. My corrected orbit is as follows:—

Epoch of Mean Anomaly, 1846, March 0<sup>o</sup>, G.M.T. = 0<sup>o</sup> 27' 24"·6

Longitude of Perihelion..	116° 28' 23"·9	} Mean Equinox of Epoch.
Ascending Node.....	102 37 40"·5	
Inclination .....	30 57 50"·8	
Angle of Excentricity ...	52 36 15"·2	
Log. Semi-axis Major	0·5000430	
Period of Revolution	5 <sup>m</sup> ·624	

“Referring the co-ordinates of the comet and planet to the ecliptic, we find,

G.M.T. 1842.	Comet.			Jupiter.		
	<i>s</i>	<i>y</i>	<i>z</i>	<i>s</i>	<i>y</i>	<i>z</i>
May 0	+1·1902	−5·0230	−0·0372	+1·0666	−5·0775	−0·0062
10	·2261	·0426	·0559	·1396	·0578	·0079
20	·2621	·0619	·0749	·2126	·0372	·0097
30	·2982	·0806	·0934	·2851	5·0155	·0114
June 9	+1·3344	−5·0987	−0·1120	+1·3576	−4·9926	−0·0131

whence the real distances between the comet and *Jupiter* will be,

$$\text{May 0} = 0·1386$$

$$10 = 0·1001$$

$$20 = 0·0856$$

$$30 = 0·1055$$

$$\text{June 9} = 0·1468$$

“The nearest approach would occur about May 19, on which day the distance would amount to 0·085, or 8,100,000 miles. These results are, of course, independent of the effect of perturbation between 1842 and 1846, but they appear to shew that the calculation of *Jupiter's* disturbances backward to the early part of the former year would conduce to some very interesting results. The similarity between the orbit of Brorsen's comet and those of the comets of 1532 and 1661, long supposed to be identical, may of itself be considered sufficient inducement to some one accustomed to these intricate computations to undertake the solution of the question with all possible accuracy.”

*Extracts of Letters from Mr. Lassell.*

"You will, I am sure, be pleased to hear that I have gained a long march further in the art of figuring specula. I have successively refigured both the 20-foot mirrors, which are decidedly superior (especially A, that now in the tube) to the surface with which I made all my observations last year. I shall therefore enter the field with *Neptune*, *Uranus*, &c. on a vantage ground this year. The improvement I have made is not so much in the greater correctness of the general curve as in its greater regularity and continuity, producing superior definition, and neater, rounder, and harder disks of stars. I have attained a much more complete control over the polishing machine, and take to it now, without risk of injury and with strong probability of improvement, surfaces such as formerly I dared not touch. I am now fully persuaded of the competency of the machine to do all I ever hoped from it, and more than I ever hoped in giving correct curves with short foci. I have lately made a 12-inch mirror of  $89\frac{1}{2}$  inches' focus without sensible error from the parabola, and sharper in definition than I had ever previously made a 9-inch mirror of 112 inches' focus. Stars are beautifully shewn by it, even the most difficult doubles, such as  $\zeta$  *Herschel* and  $\delta$  *Cygni*, the severest tests of telescopes. The best figures also on the 9-inch I have hitherto obtained are thrown into the shade by some recent surfaces, which shew me that a degree of excellence is attainable of which I had never before dreamt. Such pictures of stars I never saw before. These figures on the smaller specula, and the improved surfaces of the 20-foot, give me sanguine hopes of still further excellence in the latter, and to this point I am now bending my attention. I am surprised by the *quality* of vision of the short-focus telescope. I see no increase of loose light about a star, nor greater hardness of rings; nor should I know by any inferiority of vision that I was not looking with a focus of 12 diameters. I have improved the mode of supporting the 20-foot mirror."

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Mr. Lassell mentions the following particulars respecting the fourth satellite of *Jupiter*. On the 13th of June, in the early part of the evening, this satellite seemed so small as to suggest the idea that it was a faint star which had got accidentally in the line of satellites. A little later, the satellite was again noticed with another telescope, and appeared *reduced to one-half its ordinary magnitude*. At about  $10^h$  it was far from being obvious in an excellent Gregorian of 4.7 inches' aperture: indeed, it was not seen for some time by a young lady who is not unaccustomed to look through telescopes. Mr. Lassell further remarks, "that the transits of the fourth satellite and its shadow over the disk of *Jupiter* seldom occur; in these cases, however, the satellite appears as a large dusky spot,

and the shadow is a black spot much larger than that of any other satellite, not excepting the third. This would seem to shew that the fourth is the largest satellite, though, when seen off the disc, it generally appears to be the smallest, and is always, I think, the least luminous."

"The variation of brightness seems to indicate a revolution on its axis. I have no doubt that in a less degree the third satellite is partially obscured by dark shades or spots; for when seen on the face of *Jupiter*, its form is an irregular oval, though the shadow is round."

Mr. Lassell proposes to re-examine these satellites with care when *Jupiter* is next in opposition.

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*On an improved Compensation-Balance.\** By Mr. Hartnup,  
Director of the Liverpool Observatory.

"The Liverpool Observatory was established chiefly for rating and testing the chronometers of vessels which sail from that port. In a large majority of cases the seaman relies solely on his time-keepers for the determination of longitude, and is frequently unable to employ any other means. Hence it became my especial duty, as director of this establishment, to devote my attention particularly to everything which could improve the going of marine chronometers. On my appointment I gladly availed myself of the permission of the Astronomer Royal to make myself fully acquainted with the process of rating chronometers at the Royal Observatory, and I have mainly adopted the plan followed there.

"The chronometrical department of the Liverpool Observatory was opened to the public in the summer of 1844, and several chronometers belonging to North American packet ships were sent to be rated. The same chronometers were returned to the observatory in the following winter, after having made the voyage to New York and back. On comparing the land-rates given in the summer with the sea-rates made during the voyage, these did not differ very sensibly in those chronometers which had gone steadily at the observatory in the summer; but on rating them again in the chronometer-room, they were found to be *losing more* by from one to four seconds a-day. The chronometer-room had no fire in it, and the temperature, which in the summer had been about 60°, was now only 40°. As I supposed the change of rate arose from change of temperature, I removed the chronometers to my sitting-room, in which the temperature was about 60°, when they immediately returned to their former rates. The chronometers were removed

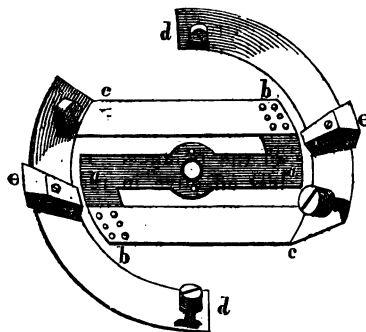
\* The reader will bear in mind, that the fault of all watches furnished with the usual compensated balance is to *lose* in *extreme* temperatures when compensated for a *mean* temperature; or, what is the same thing, to *gain* in a *mean* temperature if going correctly in extreme temperatures.

an interest in the matter the defective state of the ordinary balance, as shewn by my experiments, and the ease with which the means at my disposal enabled me to detect any fault or improvement; and on doing this on one occasion to Mr. Shepherd, he remarked that he had tried many experiments on the balance, but had not been successful, and that if I could suggest any method which I conceived would remove the tendency to lose in extremes, he would make up the balances for me to try experiments with. I agreed to do so on condition that the results of our experiments, in the event of their being successful, should be made known for the benefit of the public, and to this Mr. Shepherd, without hesitation, consented. I had many discussions with Mr. Shepherd, and made several trials, from which I concluded,—

“ 1st. That the balance-rim must be of a circular form, so that the laminæ of brass and steel might be turned down to the requisite proportions with facility, and that the compensation and poising might be easily effected, as in the ordinary balance.

“ 2d. That the balance must be so contrived that the compensating rim and weights should move towards the centre with an accelerating velocity in an increasing temperature, while in a decreasing temperature they must recede from the centre with a gradually diminishing velocity.

“ I need not mention those attempts which were either unsuccessful or which from difficulties of workmanship were not likely to be practically of use. I will describe that which is found to be easy of execution, and which is sensibly perfect in its operation.



*Fig. 1.*

“ In Fig. 1 the rim *cd*, *cd*, is composed of a strip of brass outside and a strip of steel inside, united as in the ordinary balance, and it differs from the rim of the ordinary balance only in its being *bevelled*, the angle being 45 degrees or thereabouts, as shewn in the elevation fig. 2. The bar *aa*, with the ears *ab*, *ba*, and also the bars *bc*, *bc*, are composed of brass and steel united,



Fig. 2.

as in the rim; *aa* has the brass uppermost, and *bc*, *bc*, have the steel uppermost, and they are firmly joined at *b*, *b*: *e*, *e* are compensating weights, which slide on the rim as in the ordinary balance. The screws shewn near *c*, *c* and *d*, *d* are timing and poising screws.

"Now the effect of the inclined position of the rim is this: the different expansion of the two component strips carries the weights *e*, *e*, to and from the centre, and also up or down in a *slanting* direction, owing to the bevelled form of the rim. The *slant* takes off from the action of the rim, but this is increased to the proper amount, at mean temperatures, by setting the weight more forward on the rim, so that the balance is compensated for small changes. So far the new construction acts exactly as the ordinary compensated balance.

"To shew how the new balance acts in extreme temperatures, first take the case of extreme heat. The ends of the bar *aa*, bend downwards, and the ends of the bars *cb*, *cb* curve upwards, and the compound effect of these two curvatures is to set the bevelled rim more nearly perpendicular to the plane of the balance, whence the effect of the compound rim in bringing the weights *e*, *e* towards the centre is greater than it would have been in its more inclined position. Now this tends to shorten the time of vibration of the balance. In the ordinary construction, a chronometer *loses* in extreme heat; the new construction, therefore, tends to compensate the losing rate in extreme heat.

"Again, in extreme cold, the ends of *aa* bend upwards, and the ends of *bc*, *bc*, bend downwards, from the unequal contraction of the brass and steel strips which compose the bar. The effect of this compound action is to set the rim flatter, or more nearly parallel with the plane of the balance. Hence the effect of the compound rim will be less effective in removing the weights *e*, *e* from the centre than in the ordinary construction, and the balance will move more quickly. A balance of the ordinary construction *loses* in extreme cold, hence the new balance tends to compensate the error.

"I find by my experiments that a chronometer furnished with the new balance is sufficiently compensated in all degrees of heat and cold, for a proof of which I refer to Table I. This contains the daily rates of the first three chronometers to which the above description of balance was applied from Jan. 16, to March 2, 1848, with the daily range of temperature to which they were exposed. The brass boxes containing the chronometers were suspended in gimbals, in the same way as chronometers are kept when at sea, during the whole time, thereby insuring uniformity of position under all changes of temperature.

“TABLE I.

Date 1848.	Name of Chronometer, William Shepherd.			Temperature.	
	222 Daily Gain.	228 Daily Gain.	280 Daily Gain.	Highest.	Lowest.
January 16	-1'0	-1'4	-2'4	85	70
17	-0'5	-1'3	-1'9	87	85
18	-0'7	0'1	-0'8	43	34
19	-1'9	-0'2	-1'0	35	31
20	-1'7	-0'6	-1'3	64	62
21	-0'5	-0'2	-1'3	65	62
22	-0'8	0'8	-1'2	36	33
23	-0'9	0'8	-0'7	34	31
24	-1'5	0'6	-1'1	37	31
25	-1'5	0'2	-0'2	38	33
26	-1'4	-1'2	-1'2	36	32
27	-1'4	-0'9	-0'7	73	70
28	-0'2	-0'9	-2'2	103	95
29	-0'4	-0'7	-1'7	26	20
30	-0'8	-1'1	-0'3	40	28
31	-0'1	-0'8	-0'3	43	34
February 1	-0'9	-1'7	-1'4	75	68
2	0'6	-0'8	-1'2	103	93
3	1'0	-0'2	-2'4	105	93
4	1'3	-0'1	-0'9	50	48
5	0'8	-0'5	-1'6	53	49
6	1'1	0'0	-1'5	60	53
7	0'8	-0'2	-1'5	80	73
8	0'8	-0'1	-1'6	103	93
9	1'2	0'4	-1'7	93	85
10	1'3	0'3	-0'8	70	65
11	1'3	0'5	-1'0	100	91
12	0'8	0'5	-2'1	95	87
13	1'0	0'3	-1'1	62	56
14	1'0	0'2	*	54	51
15	0'6	-0'1	1'0	55	52
16	0'4	-0'1	0'6	90	85
17	0'8	0'2	0'0	98	90
18	0'7	-0'1	0'2	38	31
19	0'1	-0'2	0'2	45	39
20	0'4	-0'4	1'2	55	50
21	0'6	0'1	1'6	70	65
22	0'8	0'6	1'2	98	91
23	0'8	0'7	0'8	90	85
24	1'0	0'8	0'8	90	88
25	1'2	0'9	1'0	97	92
26	1'6	0'3	1'7	58	54
27	1'7	0'6	2'1	57	53
28	1'9	0'8	2'3	57	53
29	1'6	0'7	Rate closed.	59	53
March 1	1'4	0'4		55	51
2	1'4	0'5	0'4	55	50

\* “The weights were moved a little further from the arm, as the chronometer appeared to lose more in heat than in cold.”

"For extreme cold the chronometers were exposed to the open air on the north side of the building; for all other temperatures they were either placed in the chronometer-room or in the heating apparatus. This apparatus is heated with hot air produced by the burning of gas, the pressure of which is regulated by a *governor*, and any definite temperature from that of the room to upwards of one hundred degrees may be kept for any required time, with a variation not exceeding two or three degrees in twenty-four hours. The artificial heat thus applied can do no more injury to chronometers than would heat arising from natural causes, and the removal of the wooden box in which the chronometer is suspended in its gimbals is rendered quite unnecessary, since heat applied in this way has little tendency to split or warp the wood.

I have given the daily rates in Table I. that they may be compared with the daily rates of chronometers with the ordinary balance, through the same range of temperature; but with the means possessed at the Liverpool Observatory, the power of the balance to compensate perfectly through a long range of temperature may be tested much more expeditiously, and the experiments repeated as often as desirable. I will give an example of the method of testing which I have practised, and which shewed, in a few hours' trial, the defect in all the constructions which were devised by me, and made by Mr. Shepherd, previous to that which I have described.\*

"In my first experiments with the new balance I had ascertained what I had not been able to make out with the ordinary balance,—namely, that by a sudden change in the temperature of  $20^{\circ}$  or  $30^{\circ}$ , the balance-spring was affected sooner than the balance, and that a sudden immersion into a temperature higher by  $20^{\circ}$  or  $30^{\circ}$  caused the chronometer to lose, during the first hour, two or three tenths of a second more than it afterwards did by continued exposure to the same temperature. By sudden immersion into a lower temperature of  $20^{\circ}$  or  $30^{\circ}$  the same variation took place, but with a contrary sign, and the chronometer gained two or three tenths of a second more during the first hour than afterwards. But by changing the temperature *gradually*, and at the rate of not more than  $8^{\circ}$  or  $10^{\circ}$  an hour, the balance appears to be sensibly affected as soon as the spring.

"To shew the difference between the ordinary and the improved balance, I subjoin Table II., which contains the rate of the same chronometer with balances on the two constructions. Col. 1 is the interval in decimals of a day, at the beginning and end of which the chronometer was compared by coincident beats with a sidereal chronometer, and the highest and lowest temperatures noted.

\* "By a test similar to that in Table II. an improvement was shewn in the very first balance with the dished rim, and by the application of the compound centre bar it was rendered so perfect that I have not yet been able, notwithstanding the numerous experiments which I have since tried on twelve consecutive chronometers of this construction, to detect any sensible tendency either to lose or gain in extremes."

Col. 2 is the deduced daily rate. Cols. 3 and 4, the temperatures. These are in the order of time. At the side are two other columns, in which the daily rates are arranged in order of temperature.

"TABLE II.

William Shepherd, 222. *Ordinary Balance.*

Days.	In order of Time.			In order of Temperature.	
	Daily Gain.	Highest. Temperature.	Lowest.	Daily Gain.	Mean Temperature.
0.242	-5.8	47	37	-9.0	34.5
0.683	-0.7	82	65	-5.8	42.0
1.084	-2.4	102	82	-3.7	50.5
0.064	-4.1	108	102	-1.0	65.0
0.684	-5.8	113	108	-0.7	73.5
0.542	-5.6	113	102	-1.7	83.5
1.180	-1.7	102	65	-2.4	92.0
0.767	-1.0	65	65	-4.1	105.0
0.685	-3.7	65	36	-5.6	107.5
1.001	-9.0	36	33	-5.8	110.5

William Shepherd, 222. *Improved Balance.*

Days.	In order of Time.			In order of Temperature.	
	Daily Gain.	Highest. Temperature.	Lowest.	Daily Gain.	Mean Temperature.
0.375	-2.9	34	33	-2.5	28.5
0.500	-2.4	33	32	-2.4	32.5
0.127	-3.2	33	32	-3.2	32.5
0.980	-3.4	73	33	-2.9	33.5
0.249	-3.6	103	73	-2.9	37.0
0.753	-1.9	103	95	-3.2	51.5
1.000	-2.5	35	22	-3.4	53.0
1.002	-2.9	40	34	-2.4	71.5
0.125	-3.2	68	35	-3.6	88.0
0.875	-2.4	75	68	-2.0	88.5
0.250	-2.0	102	75	-1.9	99.0

"Between the trials with the old and new balances, the chronometer was not cleaned. Nothing whatever was done to it, except the detaching of the old balance from the spring, securing the new one to it, and adjusting the weights of the new balance, so as to effect the compensation. The variation of rate due to extreme temperature in this chronometer *with the ordinary balance* is about the quantity which I have usually found in good chronometers from a similar change of temperature.\*

\* "Immediately subsequent to these experiments, I requested Mr. Shepherd to allow me to ask to have the same chronometers tested at the Royal Observatory. Not that I had the least doubt on my own mind as to the efficiency of the balance, but because I thought the principle would be sooner adopted by chronometer-makers, on a successful report appearing from Greenwich, than by any other means which I could adopt. The Astronomer Royal, on my application to him, very kindly obtained permission to have this done, and the rates of the three chronometers in Table I. are published in the list of trials for 1848.

"Selecting from the Greenwich rates the two weeks of highest and lowest

"The disadvantage of the new balance is, so far as I know, merely in the additional trouble of construction. Mr. Shepherd thinks that it requires at least twice the labour of the ordinary balance. The

temperature, and that which corresponds the nearest to the mean between them, we have the following rates:—

*"William Shepherd.*

	222	228	230	Temperature.	
	Daily Gain.	Daily Gain.	Daily Gain.	Max.	Min.
March 11 to 18	—2·7	—1·1	—0·5	46°	40°
April 1 to 8	+1·0	+0·4	—1·2	71	63
May 6 to 13	+1·4	+0·5	—3·1	110	85

"Selecting again another set in a similar way, in which the temperatures are not very widely different, we have

	222	228	230	Temperature.	
	Daily Gain.	Daily Gain.	Daily Gain.	Max.	Min.
April 22 to 29	+0·9	—0·3	—2·2	58°	46°
July 1 to 8	+0·2	+1·1	—0·5	77	57
June 17 to 24	+1·6	+2·0	—2·4	107	82

"Now, by comparing the two sets, it will be seen that the rates differ from each other in similar temperatures, nearly as much as they differ from each other, in each set, in different temperatures; and it appears to me that the law of variation between the balance and spring cannot be deduced from such discordant results.

"The trial does, however, shew that the chronometers did not go so steadily at Greenwich as at Liverpool; and I can account for this in no other way than by supposing that it arose from the chronometers being taken out of their gimbals, which I now understand was done at Greenwich.

"I understand from Mr. Shepherd, that No. 228 was purchased by the Government; Nos. 222 and 230 were again tested by me subsequent to the Greenwich trial. In the wooden boxes mounted in gimbals the rates were as steady as those given in Table I. When out of the gimbals, and standing on the table, a projecting pin at the bottom of the brass box inclined the face of each chronometer at an angle of about 4°, more or less, depending on which side of the face was elevated, the pin not being in the centre of the bottom of the box. In this state the rates were quite as discordant as the Greenwich rates, owing, as I at the time supposed, to the inclined position of the chronometer; but I now think that part of the irregularity arose from the unsteady way in which the box was supported: resting, as it did, on the end of the pin and the rounded part of the bottom of the brass box, the vibrations of the balance might cause the chronometer to attain an oscillatory motion. I understand from Mr. Shepherd, that the chronometers had only been poised in the callipers.

"There is no difficulty in making chronometers go at nearly the same rate with the 3, 6, 9, and 12 upwards; but when this is done, box chronometers generally gain several seconds a-day more with the face upwards than in any of the above-named positions. I am not aware of any method of getting rid of this fault, except that of making the chronometer fast in the short vibrations; but the remedy is certainly worse than the disease.

"So far as my experience goes, an error in positions of 10° or 15° is of little practical importance in chronometers employed for nautical purposes. I have tested a great many timekeepers of different makers, and have frequently found chronometers, which have been celebrated for their steady rates when free in their gimbals, upwards of half a minute a-day out in positions.

"This is, however, a question which has no bearing on the balance which I have described, since that may be poised in positions with as much facility as the ordinary balance."

advantage is, that when made to compensate for any two distant temperatures, such, for instance, as  $60^{\circ}$  and  $90^{\circ}$ , or for  $30^{\circ}$  and  $60^{\circ}$ , I have found the compensation equally perfect in the lowest temperature which I have been able to obtain, or in the highest that I could risk the chronometer in, and sensibly the same in all intermediate temperatures. I have subjected chronometers with this description of balance to temperatures as high as  $124^{\circ}$  and as low as  $20^{\circ}$ , and whenever a loss has been found at one extreme, a tendency to gain at the other extreme has invariably presented itself. Under these circumstances, and as I understand from Mr. Shepherd that he applies this description of balance to all the chronometers which he now makes, pocket as well as box, I am anxious to make it known that chronometer-makers and the public may avail themselves of it if they think fit."\*

*Description of a small Transit-room, with Section and Plan.*

By Mr. Dell.

The dimensions of this room are  $7\frac{1}{2}$  feet in the meridian,  $5\frac{1}{2}$  feet wide, and  $6\frac{1}{2}$  feet high. By placing the pier and window-slits a good deal on one side, Mr. Dell finds he has room enough for the clock and a desk.

The instrument,—a 30-inch transit by Jones,—stands on a stout stone, resting on a brick pier, which descends  $2\frac{1}{2}$  feet below the ground. The building itself is of wood, which, being screwed together, can be taken apart and set up again in a very short time, if necessary. The cost, including labour and materials, did not exceed 6*l*.

Mr. Dell is well satisfied with the steadiness of the instrument.

Before placing the transit in the meridian, Mr. Dell observed  $\gamma$  *Ursæ Majoris* and  $\gamma$  *Draconis* on the prime vertical, and deduced, as a mean result, Lat.  $51^{\circ} 48' 54''\cdot 7$  N.

The observatory was found, by measurement, to be 522 feet south and 295.5 feet east of Aylesbury spire, or  $5''\cdot 1$  and  $0''\cdot 31$  respectively. Adopting the data of the survey, viz.—

N. Lat. =  $51^{\circ} 49' 1''\cdot 0$  and  $3'' 17''\cdot 07$  W.,†

Mr. Dell's observatory is in

Lat.  $51^{\circ} 48' 55''\cdot 9$  N. and Long.  $3'' 16''\cdot 76$  W.

Mr. Dell also finds,—

Hartwell Observatory 4679 feet South, 6842.8 North of Aylesbury Spire

Stone Observatory 6577 ——— 11330.0 ———

The Rev. J. B. Reade recommends that the eyehole of the ordinary negative, or Huyghenian, eyepiece should be much reduced

\* "I hope shortly to have an opportunity of testing this balance in the extreme temperatures of Cambridge, U.S."

† Is this the longitude of the published survey, in which an erroneous figure of the earth was used, or a corrected longitude? The difference is about  $0''\cdot 8$ .

in size, when the telescope is used for viewing the sun. He finds that, with a small eyehole, such as is necessary in the Gregorian telescope, the whole aperture of the object-glass may be used without endangering the dark shade.\* The eyehole should be placed where an image of the object-glass is formed by the eyepiece, or, what is the same thing, where the axes of the different pencils cross each other. The aperture of the hole should not be less than the image formed by the object-glass, and need not be larger. Mr. Reade finds, from actual experience, that this position and limitation of the eyehole greatly improves the definition of the telescope for all celestial objects.

*Extract of a Letter from Captain Hardy to Dr. Lee.*

"I wish to call your attention to four remarkable spots, all belonging to the same mass, which are now (May 8) passing across the sun's disc. They entered his upper limb on the 29th or 30th of April, a little to the eastward of his north pole. They proceeded southward in nearly a straight line, and the principal spot crossed his equator about May 4. They are now approaching the lower limb, and are, at 3<sup>h</sup> 30<sup>m</sup> this day, two-thirds of the way down. The form of this mass is singular, and in many respects different from anything I have seen before."

A series of drawings of the sun has been forwarded from Poona by Capt. Jacob. Capt. Jacob, we are informed, has been appointed to succeed the late Mr. Taylor at the Observatory of Madras.†

*Lunar Theory.*

It will be remembered that in the investigation of the correction of the Elements of the Moon's Orbit required by the Greenwich Lunar Observations, the Astronomer Royal pointed out the following term as not recognised by theory but of undoubted existence :

$$\text{Inequality in the Moon's Latitude} = +2'' \cdot 17 \cos u;$$

\* Mr. Reade is of opinion that the thermal rays, in a refracting telescope, do not follow the same course as the illuminating rays; that they are considerably diffused at the eyehole, and that a large portion is stopped there when the eyehole is small. Have any experiments been made to ascertain the path of thermal rays when transmitted through an achromatic object-glass and through different kinds of glass?

† The Editor would suggest to the observers of solar spots the necessity of being very careful and specific in their *measures*. No safe conclusion can be drawn from general impressions or vague descriptions. The situations of the spots should be referred distinctly and by measure to the limbs or centre.

A guess has been hazarded that the spots are not attached to the sun, but are rather of the nature of planets or comets revolving round him. It need scarcely be stated here that there is no probability in favour of this supposition, which was exploded by Galileo on satisfactory grounds. Besides his reasons, the spots cannot be *free* bodies *near* the sun, their motions are too slow; while the absence of parallax proves that the spots cannot be near the earth, the only position which they *could* occupy to satisfy the slow motion. Every intelligible account of the solar spots seems to confirm Sir William Herschel's hypothesis, that they are variable openings in the luminous atmosphere of the sun.

where  $u$  is the moon's true longitude. (See *Monthly Notices*, 1848, June 9, vol. viii., No. 8, page 187.)

We have the gratification now to state that this term has been shewn to be a legitimate deduction from accurate theory. Our Associate, Professor Hansen, of Gotha, in a letter to the Astronomer Royal, has given the following account of it:—It is known by elementary investigations in physical astronomy that, supposing the plane of the earth's orbit to be invariable, the mean inclination of the moon's orbit to the earth's orbit is constant. Laplace made a very important addition to this theory in shewing that, though the plane of the earth's orbit is undergoing a change from the action of the planets, steadily progressing in one direction, yet the mean inclination of the moon's orbit to the variable plane of the earth's orbit will be sensibly constant. Now, Professor Hansen has introduced a slight modification in this theory. He finds that the position of the moon's orbit will be more correctly represented by the following conception. "Take the plane of the earth's orbit in the position in which it was about three years ago; let the nodes of this plane revolve backwards on the present ecliptic through  $90^\circ$ , without change of inclination, the plane so found is the plane to which the uniformity of inclination of the moon's orbit is to be referred." The effect of this, omitting terms which are inseparably mingled with other terms, is to produce in the moon's latitude the inequality,—

$$= +1''\cdot38 \cos \text{moon's longitude};$$

that found from the observations,—

$$= +2''\cdot17 \cos \text{moon's longitude}.$$

The same train of investigation has given a term in the moon's longitude,—

$$= -0''\cdot50 \cos \text{longitude of node};$$

while that deduced from the observations, and hitherto unexplained, is,—

$$= -0''\cdot97 \cos \text{longitude of node}.$$

The small differences which remain are in all probability due to errors of observation."

After the termination of the sitting, the Astronomer Royal exhibited a specimen which he had received from Mr. May, illustrative of the construction of the pivots of the new transit circle for the Royal Observatory, of which the massive parts are now progressing under the superintendence of Mr. May. By long meditation on the causes of uncertainty in instrumental observations, and more particularly by consideration of the state of the Cape Mural Circle, in which (after its return to England), it was found that its steel axis-collar had been merely fastened on by soft solder, and could easily be turned by hand, the Astronomer Royal had been led to the determination that, in every new instrument constructed under his direction, the pivots should be cast in the same flow of metal with the parts which they immediately support. The advantages which cast-iron presents for the construction of large instru-

ments (from the facility with which it is cast, and its small thermal expansion when in the manufactured state), had long made him desirous of using that material. And Mr. May had pointed out to him that these objects might be obtained, giving at the same time extreme hardness to the surface of the pivot, by the process called *chilling*, in which the pivot, or other part to be hardened, is cast in a mould of iron at a certain temperature, other parts (in the same flow of metal) being cast in sand in the usual manner. The chilled surface is too hard to be turned on the lathe by a tool in the ordinary way, but it may be turned with most perfect accuracy, and most complete command of its surface, by using, instead of an ordinary tool, a leaden wheel charged with emery, which is turned with great rapidity, and is at the same time moved backwards and forwards in the direction of the axis of the pivot: the pivot being turned slowly to it as in the ordinary lathe-turning.

The specimen forwarded by Mr. May was a part of a perforated cylinder, in all respects similar to the instrument-pivots, which had been chilled in casting, had been turned and ground in the manner above described, and had been broken, so as to shew the depth to which the chilled structure penetrates.

It has already been mentioned that the splendid heliometer by Repsold (the largest and most perfect instrument, we believe, now existing of its class) has been received at the Radcliffe Observatory quite safe. The Trustees have directed that it should be mounted with corresponding magnificence, and the building is now nearly completed. A handsome round stone tower, in advance of the east wing of the observatory, is carried up high enough to give the instrument a clear view to the north horizon; the south is open, and the only direction in which the view is confined is to the north-west, where the central tower of the observatory intercepts an unimportant part of the sky. We are confident that in Mr. Johnson's hands the instrument will do credit to the talents of the artist, and justify the discerning liberality of the Radcliffe Trustees.

Books, papers, &c. for Professor Schumacher may be forwarded to Mr. Dent, who will transmit them to Altona as occasions offer.

Mr. Beaumont wishes to dispose of a transit telescope,  $2\frac{1}{2}$  inches' aperture, of the best construction, with its Y's, near collimating mark and lens, morocco observing chair, and copper shutters, for 80*l.* The original cost was above 200*l.*

Also of a clock by Molyneux.

#### ERRATA.

In Mr. Airy's Circular of May 21, in the epoch *for* "March," read "*May.*"

P. 139, Captain Shea *presented* his book of drawings.

P. 143, line 28, *for* "L +," read "L —"

" " *for* "L' +," read "L' —"

but it is safer to work out each case according to its nature, and not to follow a formula.

## ROYAL ASTRONOMICAL SOCIETY.

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VOL. IX.

Supplement.

No. 9.

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### *United States' Astronomical Expedition to Chile.*

IN a former number, notice was given of an astronomical expedition to Chile for the purpose of determining the parallaxes of *Mars* and *Venus* near opposition, and thence concluding the parallax of the sun. Dr. Gerling, of Marburg, suggested this undertaking in the *Astronomische Nachrichten*, and Lieut. Gilliss, U.S.N. has been appointed to the charge of it. Instructions have been drawn up by Lieut. M. F. Maury, U.S.N. Superintendent of the National Observatory; and copies of this circular have been forwarded by Lieut. Gilliss to most of the observatories in England,\* asking for such co-operation as it may be thought expedient to afford.

Lieut. Gilliss proposes to measure the position of the planets with respect to certain fixed stars at given dates which are carefully tabulated. The planets and stars are also laid down on charts on a convenient scale. Corresponding observations on the same days with the same stars, and meridian observations of the planets, are wanted.

“Those astronomers who are disposed to forward the objects of the expedition, so far as to co-operate with it in conducting an auxiliary series of observations, will perceive that the results of their labours will be enhanced by using, wherever practicable, the stars of comparison which Lieut. Gilliss has selected, and which are given in Tables I. and II. of the circular, and by following the plan of observations proposed by him and herein explained.

“Each co-labourer is requested to send annually to the Superintendent of the National Observatory, at Washington, his observations, with an account of the instruments with which they were made, together with such other information in relation thereto as is necessary to a full understanding and appreciation of them and the results arising therefrom.”

As some delay may occur in forwarding copies of the circular to observers who would wish to join in the operation, the approximate places of the following stars are extracted from the circular, for comparison with *Mars* in November next:—

\* There are a few spare copies of the circular which will be given to any gentleman, on application, who possesses the inclination and astronomical means of making corresponding observations.

	Mag.	R.A. h m s	N. Decl. ° ' "	Days of Comp.
Bessel Z. 348	9	6 18 48	24 20 52	1, 2
—	9	27 55	31 37	3, 4, 5, 6
—	7·8	29 6	35 6	7, 8
B.A.C. 2154	6·7	28 15	42 32	9, 10, 11
H.C. 12557	9	25 51	44 42	12, 13
Bessel Z. 348	9	28 47	24 58 22	14, 15
H.C. 12554	8	25 48	25 2 4	16, 17
Bessel Z. 348	9	19 54	9 35	18, 19
— 523	9	21 15	13 36	20, 21
— 523*	9	24 2	22 24	22
— 523	9	18 9	26 47	23
— 523	9	21 45	30 43	24, 25
H.C. 12237	9	16 51	35 35	26
— 12240	8	16 58	40 39	27, 28
— 12041	8	11 18	40 19	29
Bessel Z. 405	9	6 11 37	25 45 34	30

The place of the planet may be taken from the *Nautical Almanac*.†

\* Double, observe south preceding star.

† The attention of observers is particularly directed to the presumed variability of the *apparent* diameter of *Venus*, from whatever cause this may arise. It is recommended that the diameter of the planet should be very carefully measured before and after each set of comparisons with the neighbouring star. It would be prudent to make similar measures of *Mars* so as to have the power of eliminating the effect of any telescopic or personal differences.

## NEPTUNE.

LIVERPOOL.		Equatoreal.		(Mr. Hartnup.)	
1849.	Greenwich M.T. h m s	R.A. h m s	N.P.D. ° ' "	Star.	
Aug. 21	12 41 3·4	22 22 56·89	100 53 33·1	B.A.C. 7918	
Sept. 5	10 50 40·5	21 23·77	101 2 32·3	B.A.C. 7773, 7892	
7	10 38 6·9	22 21 11·61	101 1 41·8	— — —	

“ The observations are corrected for refraction and parallax.

“ 7892 B.A.C. is a neat double star. The components are of equal brightness, differing in R.A. about 0·5, and in N.P.D. about 3". The comparison here made is with the star which precedes in R.A.”

HAMBURG.		(M. Rümker.)	
1849.	Hamburg M.T. h m s	R.A. h m s	Decl. ° ' "
July 25	11 57 33·6	336 23 3·3	—10 38 2·0
28	11 36 4·3	19 5·7	39 37·3
30	11 51 51·0	16 28·6	40 40·2
31	13 46 52·6	15 0·2	41 20·7
Aug. 1	11 1 30·6	336 13 49·7	—10 41 44·1

Equat.

—

—

Merid.

Equat.

*Lassell's Satellite of Neptune.*

LIVERPOOL.

(Mr. Lassell.)

1849.	Green. M.T.	Position.	No. Obs.	Distance.	No. Obs.
	<sup>h</sup> <sub>h</sub> <sup>m</sup> <sub>m</sub> <sup>s</sup> <sub>s</sub>	<sup>°</sup> <sub>°</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>			
Sept. 8*	12 15	39 30	5		
	12 35			18.28	4
17	8 25	216 11	3		
	8 45			14.93	2

\* "Sky bright and circumstances favourable; power 366. The distances on Sept. 8 seem large, but I thought them good at the time."

## METIS.

CAMBRIDGE.

Northumberland Equatoreal.

(Prof. Challis.)

1849.	Green. M.T.	R.A.	N.P.D.	No. of Obs.	Star.
	<sup>h</sup> <sub>h</sub> <sup>m</sup> <sub>m</sub> <sup>s</sup> <sub>s</sub>	<sup>h</sup> <sub>h</sub> <sup>m</sup> <sub>m</sub> <sup>s</sup> <sub>s</sub>	<sup>°</sup> <sub>°</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	R.A. N.P.D.	
June 13	13 41 46.4	22 35 53.53	105 37 16.5	1 1	♈ Aquarii.
	44 12.9	53.36	11.2	2 1	H.C. 44292
22	13 36 16.1	22 40 46.18	105 39 47.0	10 10	♈ Aquarii.

Corrections for parallax, computed from Mr. Graham's first ephemeris, have been applied. The place of ♈ Aquarii is taken from the British Association Catalogue, and that of the other star from Lalande.

HAMBURG.

Equatoreal.

(M. Rümker.)

1849.	Hamburg M.T.	R.A.	Decl.	
	<sup>h</sup> <sub>h</sub> <sup>m</sup> <sub>m</sub> <sup>s</sup> <sub>s</sub>	<sup>°</sup> <sub>°</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	<sup>°</sup> <sub>°</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	
July 22	12 51 0.9	340 37 41.8	-17 18 4.7	
25	13 24 56.1	340 19 57.0	35 20.7	
28	12 18 38.0	339 58 44.9	17 52 56.8	
30	12 40 15.2	42 13.7	18 5 15.5	
31	13 59 59.8	32 18.9::	11 48.2::	
Aug. 1	11 26 24.8	339 25 4.4::	18 17 16.3::	
11	11 38 26.5	337 34 45.0	19 23 41.1	
13	12 59 15.5	.....	-19 37 17.9	Mer. Circle.
	14 4 46.1	337 7 29.7	28.7	

## CERES.

LIVERPOOL.

Equatoreal.

(Mr. Hartnup.)

1849.	R.A.	N.P.D.	Comp <sup>d</sup> —Obs <sup>d</sup> .	Star.
	<sup>h</sup> <sub>h</sub> <sup>m</sup> <sub>m</sub> <sup>s</sup> <sub>s</sub>	<sup>°</sup> <sub>°</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	R.A. N.P.D.	
July 9	18 18 19.68	118 25 43.9	+11.36 +7.1	B.A.C. 6191
10	17 25.02	28 43.5	11.54 2.9	B.A.C. 6191, 6371
11	16 31.30	31 32.6	11.50 4.4	— —
13	18 14 46.03	118 36 58.6	+12.64 +5.2	— —

"For the Liverpool observations of *Pallas* and *Ceres* the equatoreal was firmly clamped in the meridian, and used as a transit-circle. The observations are corrected for refraction and parallax, and compared with the ephemeris published in the *Nautical Almanac*."

## HYGEIA.

CAMBRIDGE. Northumberland Equatoreal. (Prof. Challis.)

1840.	Green. M.T.			R.A.			N.P.D.			No. of Obs.		Star.
	h	m	s	h	m	s	°	'	"	R.A.	N.P.D.	
May 29	9	44	10.8	12	3	11.23	95	29	50.3	6	2	Bessel, xii. 35
	10	17	5.3			11.49			58.8	9	5	— —
31	10	27	21.2	3	50	26	30	57.3		1	1	B.A.C. 4080
	10	44	6.0			49.14			45.1	10	8	Bessel, xii. 35
June 8	10	44	52.3	7	8	92	95	39	2.2	1	1	B.A.C. 4080
	10	47	44.4			8.17			39	1.6	2	Bessel, xii. 35
	11	3	5.6			8.40			38	54.6	5	Bessel, xii. 74
22	10	35	40.0	15	41	13	96	12	3.0	6	2	B.A.C. 4171
23	10	23	43.5	16	24	98			15	14.7	5	— —
25	10	34	16.6	17	56	47			21	56.4	1	— —
27	10	6	27.7	.....			96	28	53.8		2	Bessel, xii. 297
July 6	10	3	29.0	12	27	14.46	97	6	13.2	1	1	B.A.C. 4257

"No correction has been applied for parallax. The places of the stars are adopted from the cited authorities, attention being paid to the *Corrigenda* appended to Weisse's Catalogue. After June 23 the observations were obtained with great difficulty and are somewhat uncertain."

## PALLAS.

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

1840.	R.A.			N.P.D.			Comp <sup>d</sup> —Obs <sup>d</sup> .		Star.
	h	m	s	h	m	s	R.A.	N.P.D.	
July 9	17	30	30.31	66	44	28.0	+0.21	+12.0	B.A.C. 6005
10		29	51.45		51	17.1	-0.23	10.8	— —
11		29	12.82	66	58	21.9	+0.01	7.2	B.A.C. 5883, 6005
13	17	27	58.86	67	13	6.0	+0.09	+5.8	— — —

## SCHWEIZER'S COMET.

MARKREE. With the Meridian Circle. { E. J. Cooper, Esq.  
& A. Graham.

1840.	Greenwich M.T.			R.A.			Decl.	No. of Wires.
	h	m	s	h	m	s		
April 25	10	56	26.1	12	17	54.33	+12 43 41.4	7
26	10	12	26.2	11	57	47.06	9 49 46.5	7
28	9	23	39.4	11	16	30.49	+3 27 11.0	2

Corrected for parallax by Schweizer's elements, *Ast. Nach.* No. 680.

## Notes.

April 25. Bisection good; transits uncertain.  
28. Very uncertain; hazy.

## With the large Equatoreal.

1849. April 14	Greenwich M.T.			R.A.			Decl.	Relative Weights.	Star of Comp.
	h	m	s	h	m	s			
	11	38	37.5	14	49	27.06	+ 27 40 16.8	5.00	a, b, c
15	13	18	48.5	40	27	11.1	27 10 53.4	4.00	d
16	12	19	3.0	31	32	38	26 38 5.9	6.00	e
17	10	25	32.6	14	22	8.67	26 0 22.3	6.00	f
19	12	17	29.3	13	57	31.82	24 5 26.2	3.33	g
23	10	46	39.0	12	56	8.10	17 44 3.8	0.75	h, i
	12	58	32.3	54	28	9.1	31 45.1	3.75	h, i
24	10	7	37.8	37	59	17	13 26 52.3	3.50	k
	12	43	20.9	35	54	8.9	10 24.0	3.67	k
25	9	44	18.8	12	18	38.80	12 49 55.9	5.00	l, m
26	9	49	14.8	11	58	7.67	9 52 40.8	3.00	n
28	10	2	46.0	11	15	56.15	+ 3 21 46.2	3.33	o

Corrected for parallax by Schweizer's elements, *Ast. Nach.* No. 680.

## Apparent Places of the Compared Stars and the Authorities.

	R.A.			Decl.			Relative Weights.
	h	m	s	h	m	s	
a	14	49	11.63	+ 27	44	51.9	Meridian Circle, 1 obs. 3.60
b	52	36	86	53	35	9	H. C. 27321 0.55
c	53	23	44	45	34	2	B.Z. 366; 14 <sup>h</sup> 51 <sup>m</sup> 31 <sup>s</sup> .63 0.85
d	42	29	67	27	5	16.7	Meridian Circle, 2 obs.
e	35	10	60	26	37	42.9	— — Adopted this
	11	11		40	0		B.Z. 365; 14 <sup>h</sup> 33 <sup>m</sup> 18 <sup>s</sup> .75
f	14	22	55.39	26	0	41.2	Meridian Circle, 1 obs.
g	13	59	21.53	24	6	41.8	B.Z. 412; 13 <sup>h</sup> 58 <sup>m</sup> 47 <sup>s</sup> .96
h	12	54	8.19	17	34	33.5	— 361; 12 52 18.87 1st obs. 2d obs. 0.25 1.25
i	54	47	95	17	36	22.4	— — 12 52 58.67 0.50 2.50
k	37	54	10	15	11	53.7	— 360; 12 36 6.08
l	19	57	52	12	56	1.7	Weisse, 323 2.50
m	12	20	37.58	12	39	37.3	— 343 2.50
n	11	57	32.53	9	34	9.8	B.A.C. 4072
o	11	18	18.34	+ 3	17	5.3	Weisse, 316

## Notes.

- April 14. The comet passed over a small star during the observation. This made the observation somewhat difficult and uncertain.
16. Well taken. There seems to-night a greater concentration of the comet's mass. The nucleus very distinct. The coma faint.
17. The comet considerably brighter. The coma much extended, almost fills field of equatoreal, but is very faint. The nucleus very distinct.
23. We cannot depend on this observation; it was made through haze.
28. The nucleus very sharply shewn.

## GOUJON'S COMET.

MARKREE.

With the Meridian Circle.

{ E. J. Cooper, Esq.  
& A. Graham.

1849.	Greenwich M.T.	R.A.	Decl.	No. of Wires.
	<sup>h</sup> <sub>m</sub> <sup>s</sup>	<sup>h</sup> <sub>m</sub> <sup>s</sup>	<sup>°</sup> <sub>'</sub> <sup>"</sup>	
April 25	9 21 2'4	11 2 18'31	+ 7 22 14'1	7
26	16 53'2	2 4'90	10 39 42'6	7
27	12 57'6	1 54'79	13 51 38'5	5
28	9 8 45'1	11 1 48'58	+ 16 56 25'8	7

Corrected for parallax by Weyer's elements.

"These observations cannot be depended on: even with dark field and illuminated wires, the comet was very faint.

## With the large Equatoreal.

1849.	Greenwich M.T.	R.A.	Decl.	Relative Weights.	Star of Comp.
	<sup>h</sup> <sub>m</sub> <sup>s</sup>	<sup>h</sup> <sub>m</sub> <sup>s</sup>	<sup>°</sup> <sub>'</sub> <sup>"</sup>		
April 24	12 1 40'2	11 2 34'69	+ 4 22 14'7	2'67	<i>a</i>
25	11 6 48'2	11 2 18'35	7 37 7'0	3'75	<i>b, c</i>
26	10 48 33'6	11 2 4'11	10 52 7'1	3'33	<i>d</i>
27	10 43 36'6	<i>e</i> + 0 6'74	<i>e</i> - 1 58'0	3'33	<i>e</i>
28	10 28 41'7	<i>f</i> - 1 6'33	<i>f</i> - 1 47'2	3'33	<i>f</i>
May 1	10 15 50'2	11 1 54'22	25 33 50'2	2'67	<i>g</i>
3	10 36 38'9	<i>h</i> + 0 51'32	<i>h</i> + 0 40'5	4'00	<i>h</i>
4	11 34 39'8	<i>i</i> - 1 46'98	<i>i</i> + 1 23'9	2'50	<i>i</i>
		<i>k</i> - 2 2'32	<i>k</i> - 0 7'4	2'50	<i>k</i>
7	10 20 1'4	<i>l</i> + 0 44'34	<i>l</i> - 1 31'7	3'33	<i>l</i>
	11 1 52'7	<i>l</i> + 0 45'15	<i>l</i> + 1 41'3	3'33	<i>l</i>
		11 3 45'33	38 54 33'2	2'50	<i>m</i>
9	11 50 46'1	<i>n</i> - 3 41'66	<i>n</i> - 8 39'5	3'33	<i>n</i>
		<i>o</i> - 4 15'35	<i>o</i> - 11 36'7	2'50	<i>o</i>
21	13 20 18'0	<i>p</i> - 1 34'79	<i>p</i> - 0 4'9	2'50	<i>p</i>
		11 15 39'43	56 16 17'8	2'50	<i>q</i>
24	11 39 8'5	11 19 20'28	58 27 11'3	3'33	<i>r</i>
29	13 2 39'1	<i>s</i> + 2 7'30	<i>s</i> + 5 26'9	2'50	<i>s</i>
		<i>t</i> + 0 15'71	<i>t</i> + 1 19'3	2'50	<i>t</i>
31	12 58 26'2	11 29 48'01	62 35 50'2	3'33	<i>u</i>
June 5	12 32 46'0	11 38 31'19	64 50 0'8	2'50	<i>v</i>
6	11 49 26'1	11 40 22'99	65 13 0'8	3'33	<i>v</i>
7	11 35 2'9	11 42 19'07	65 35 34'6	2'50	<i>v</i>
8	12 13 26'0	11 44 21'38	65 58 11'8	4'00	<i>w, x, y</i>
12	12 24 47'6	11 52 51'75	67 17 52'3	2'50	<i>z</i>
19	12 26 30'6	<i>a'</i> - 1 43'97	<i>a'</i> - 13 34'8	2'50	<i>a'</i>
21	12 7 17'6	12 15 13'31	69 37 40'3	2'50	<i>b'</i>
23	11 26 14'9	12 20 47'40	70 2 17'5	2'50	<i>c'</i>
26	12 0 55'2	12 29 50'58	+ 70 36 33'1	2'50	<i>d'</i>

"Corrected for parallax by Weyer's elements.

"The number preceding a bracket, opposite to any star, is that which should

have been placed in the column "Relative Weights," had the result for the same moment from the accompanying star been rejected.

*Apparent Places of Compared Stars and Authorities.*

	R. A.	Decl.		Relative Weights.
	<sup>h</sup> <sup>m</sup>	<sup>°</sup> <sup>'</sup>		
<i>a</i>	11 3 35.60	+ 4 19 39.6	Weisse, 42	
<i>b</i>	10 59 3.89	7 30 40.8	— 1069	2.50
<i>c</i>	11 0 25.27	7 23 18.1	— 1096	1.25
<i>d</i>	1 57.57	10 58 25.1	— 10	
<i>e</i>	1 48	14 5	Estimated	
<i>f</i>	2 55	17 8	—	
<i>g</i>	0 43.59	25 28 24.5	B.A.C. 3809	
<i>h</i>	1 26	30 33	Estimated	
<i>i</i>	4 22	32 54	—	1.67
<i>k</i>	4 37	32 55	—	1.67
<i>l</i>	3 0	38 53	—	2.50
<i>m</i>	2 26.07	38 45 1.8	B.Z. 411, 11 <sup>h</sup> 1 <sup>m</sup> 35.08	1.25 } 2d obs.
<i>n</i>	8 33	42 33	Estimated	2.50
<i>o</i>	9 7	42 36	—	1.25
<i>p</i>	17 14	56 16	—	1.67
<i>q</i>	11 19 41.05	56 30 2.5	A.Z. 100; 23 ( <i>Ast. N.</i> No. 683)	1.67
<i>r</i>	19 5.21	58 34 32.1	— 199; 16 ( <i>Ast. N.</i> 682, 683)	
<i>s</i>	24 28	61 28	Estimated	
<i>t</i>	26 19	61 32	—	1.67
<i>u</i>	29 51.63	62 28 15.9	A.Z. 184; 44 ( <i>Ast. N.</i> 682)	
<i>v</i>	38 48.33	65 14 6.4	Radcliff, II. 566, & VII. 846	
	48.29	6.4	—	
	48.25	6.4	—	2.00
<i>w</i>	45 20.02	65 53 45.4	<i>Ast. Nach.</i> 682	1.00
<i>x</i>	46 13.85	66 3 51.4	—	1.00
<i>y</i>	48 37.85	66 5 13.5	— A.Z. 186; 56	
<i>z</i>	11 53 34.53	66 58 0.6	— — 189; 44	
<i>a'</i>	12 11 36	69 24	Estimated	
<i>b'</i>	15 48.43	69 21 56.1	<i>Ast. Nach.</i> 682	
<i>c'</i>	23 27.01	70 2 30.2	B.A.C. 4222	
<i>d'</i>	12 26 59.71 + 70 37 29.4	— 4239	—	

*Notes.*

April 24. This comet is brighter than Schweizer's. The latter has a nebosity from three to four times greater than the former, and nearly concentric. Goujon's comet has a short tail in the direction opposite to the sun.

26. A small star central at 12<sup>h</sup> 20<sup>m</sup> 49<sup>s</sup> Markree Sid. Time.

May 21. Occasional gusts of wind may have affected the observation to-night.

June 23. Excessively faint. The first two sets are little better than guesses.

26. Faint, but better shewn than on the 23d.

The stars marked A.Z. (Argelander's Zones) have been taken from the *Ast. Nach.* We have not access to the original. It is probable that some of the stars of which rough places are given, have also been observed by Professor Argelander.

## CAMBRIDGE. Northumberland Equatorial. (Prof. Challis.)

1849.	Green. M.T.			R.A.			N.P.D.			No. of Obs.	
	h	m	s	h	m	s	°	'	"	R.A.	N.P.D.
Sept. 11	12	0	38.4	18	7	48.47	28	43	30.4	8	9 Arg. Z. 125; 144
17	9	12	25.9	18	27	51.08	31	14	2.2	3	3 B.A.C. 6289
	11	0	1.4	28	3	7.1	15	55.4	8	8	—
19	9	58	36.6	18	34	25.16	32	7	13.6	3	3 Arg. Z. 20; 30

"Parallax has not been applied. The places of the stars have been adopted from the authorities cited. The second series on Sept. 17 was taken by transits at two parallel bars, inclined alternately  $+45^\circ$  and  $-45^\circ$  to the parallel of declination. The comet was extremely faint.

## LIVERPOOL. 20-foot Reflector. (Mr. Lassell.)

1849.	Greenwich M.T.			R.A. Comet.			No. Obs.	N.P.D. Comet.			No. Obs.
	h	m	s	h	m	s		°	'	"	
July 13	12	40	42.80	a + 4	49	80	6	a - 0	35	15	6
31	12	29	5.21	b - 1	57	70	6	b + 0	47	32	6
Sept. 11	13	14	2.3	c - 1	10	67	6				
		14	31.6					e - 5	52	0	6
17	9	48	15.0	d - 0	46	64	10				
		47	52.5					d + 0	43	3	10

"The observations not corrected for refraction or parallax; power 219.

	Mag.	Mean R.A.			Mean N.P.D.			
		h	m	s	°	'	"	
a	6	13	27	55.54	17	25	36.8	= Arg. Zones 200; 104
b	6	15	0	17.81	17	38	39.0	= { B.A.C. 4978, & Rad. VI. 1137; VII. 1019
c	6.7	18	8	9	28	50	7	
d	8	18	28	7	31	15	6	

## LIVERPOOL. Equatorial. (Mr. Hartnup.)

	Greenwich M.T.			R.A.			$\text{Log } \frac{p}{P}$	N.P.D.			$\text{Log } \frac{q}{P}$	Star B.A.C.	
1849.	h	m	s	h	m	s		°	'	"			
July 8	11	24	28.2	13	11	51.93	+9.104	17	47	9.3	-9.064	4506	
	11	47	24.6			56.06	9.112			4.4	9.236	—	
13	12	24	45.0	13	32	35.26	9.124	17	25	9.4	9.409	—	
	12	49	16.5			41.23	9.120	24	59	1	9.503	—	
Aug. 16	13	8	30.1	16	18	45.72	9.062	20	10	50.9	9.504	5628	
18	11	16	40.9	28	0	60	9.020	20	37	55.4	8.845	5514	
21	11	0	38.1	16	41	58.16	8.983	21	24	15.4	8.453	5543	
	11	29	46.2			42	5.46			38.3	8.965	—	
Sept. 8	10	9	28.8	17	56	41.94	8.807	27	28	23.0	8.147	6224	
	10	43	31.3			45.69	8.857			29	13.2	8.883	—
17	10	20	19.6	18	28	0.50	8.780	31	15	4.5	8.993	6395	
	11	14	57.1			6.95	+8.844			54.7	-9.308	—	

"The observations are corrected for refraction. The corrections to be applied for parallax in time and arc are represented by  $p$  and  $q$ .  $P$  is the equatorial horizontal parallax. The observations very good, with the exception of the 16th Aug. The stellar nucleus was visible in this telescope on the 21st August; the light pretty equally diffused around the nucleus."

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### ERRATA.

At p. 61, paragraph 5, substitute as follows :—"General Hodgson was appointed surveyor-general of India in May 1821, by Lord Hastings, when Governor-General, but not confirmed by the Directors, who considered the patronage to be in their hands. In lieu of this he was appointed revenue surveyor-general. In 1826 he was appointed surveyor-general, and held that office till 1827, when grief for the loss of his beloved wife induced him to resign, and to return to England."

— 28. Liverpool observations of Encke's Comet.

Oct. 10, for  $15^h 15^m 59^s$  Greenwich M.T., read  $15^h 15^m 57^s$ .

— +  $36^s.80$  corr. eph. — +  $36^s.91$ .

— 29, *et seq.* Mr. Lassell's machine is a *polishing*, not a *grinding* machine.

— 46, March 26, for  $29^h$ , read  $20^h$ .

— 47, Dec. 21, second observation, for  $-0^s.23$ , read  $-0^s.83$ .

Dec. 23, — — —  $-1^s.00$ , —  $-1^s.10$ .

Jan. 15, *delete* the four lines which are repeated.

Towards the bottom, for five transits, read six.

— 48, line 7, for six, read two; and for Jan. 11, read Jan. 15.

— 95, for Stowe, read Stone.

— 97, March 1, Comp<sup>d</sup>.—Obs<sup>d</sup>. R.A. for  $-1^s.45$ , read  $-1^s.37$ .

— 103, emersion of Jupiter's 4th satellite, for  $11^h$ , read  $14^h$ .

In Mr. Airy's circular of May 21, in the epoch, for March, read May.

— 139. Capt. Shea *presented* his book of drawings.

— 143, line 28, for L +, read L—.

— — — for L' +, read L'—.

— 197, 198, for M. Savory, read M. Savary.

— 210, line 18, for bevilled, read bevelled.

MONTHLY NOTICES  
OF THE  
ROYAL ASTRONOMICAL SOCIETY,  
CONTAINING  
PAPERS,  
ABSTRACTS OF PAPERS,  
AND  
REPORTS OF THE PROCEEDINGS  
OF  
THE SOCIETY,  
*FROM NOVEMBER 1849, TO JUNE 1850.*

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VOL. X.  
BEING THE ANNUAL HALF-VOLUME OF THE MEMOIRS AND PROCEEDINGS  
OF THE ROYAL ASTRONOMICAL SOCIETY.

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LONDON:  
PRINTED BY  
GEORGE BARCLAY, CASTLE STREET, LEICESTER SQUARE.  
1850.

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*The Council is not able to exercise systematic control over the Monthly Notices without retarding the publication so much as would greatly diminish its usefulness. The responsibility therefore rests with the Editor, who again begs to have it understood that his task is principally confined to compression and arrangement. The articles are to be estimated merely by their intrinsic merits, or by the reputation of their respective authors. A note is sometimes added to call the attention of the reader, or to recommend some precaution, and for these alone the Editor is responsible.*

*The price of this Half-volume is,—To Non-members, Five Shillings; to Fellow, Half-a-Crown.*

*The 4th Half-volume, containing the larger Memoirs for 1849-50, will appear, it is expected, about the time of the Anniversary.*

## ROYAL ASTRONOMICAL SOCIETY.

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VOL. X.

November 9, 1849.

No. 1.

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G. B. AIRY, Esq., President, in the Chair.

John Charles Dennis, Esq., 122 Bishopsgate Street, was balloted for, and duly elected a Fellow of the Society.

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Vol. IX. of the *Monthly Notices* has been published during the Vacation. Its price is fixed by the Council at 2s. 6d. to fellows, and 5s. to the public. A copy is given to the *purchasers* of the corresponding quarto volume, which is now in the press.

The *Berliner Astronomisches Jahrbuch* for 1852 contains approximate Ephemerides of *Astræa*, *Hebe*, *Iris*, *Flora*, *Metis*, *Hygeia*, and *Neptune*, for 1850, for every ten days, and an exact Ephemeris for every day during the month of opposition. It is not, therefore, the intention of the Editor to print any similar Ephemerides after the present *Notice*, unless directed by the Council, or without some special grounds.

The Smithsonian Institution have published in a separate form "Appendix I. to Volume II. of the *Smithsonian Contributions to Knowledge*, an Ephemeris of *Neptune* for the date of the Lalande Observations of May 8th and 10th, 1791; and for the oppositions of 1846, 7, 8, and 9, computed for the Smithsonian Institution by Sears C. Walker, Esq." Copies have been presented with great liberality to most of the Astronomers of Great Britain and the Continent. There is still a spare copy or two for distribution, which will be given, on application, to any fellow who proposes to make use of it.

There is one copy of the "*Circular in Relation to the Astronomical Expedition to Chile*" still left for distribution. The object of this expedition is to determine the parallax of the sun, by corresponding observations of *Venus* and *Mars* at places which are distant from each other. As the observations for this purpose are of the most delicate kind, it is not desirable that they should be attempted with inferior instruments.\*

\* Attention is again called to the absolute necessity of measuring the diameter of the planet whenever observations are made to correspond with those of Lieut. Gilliss. See the present *Notice for Measures of the Diameter of Venus*.

Part of a Memoir by the President was read, giving a history of the foundation of the Cape Observatory. Many years ago, on the death of Mr. Fallowes, his papers were forwarded to the Lords of the Admiralty, who made some ineffectual attempts to have them examined and published, if expedient. It is needless to allude here to the various difficulties which presented themselves; it will be sufficient to state, that Mr. Airy recently took charge of these manuscripts, and is now arranging and preparing them for press. Their lordships, with their accustomed liberality, have agreed to Mr. Airy's recommendation, viz. that Mr. Fallowes' observations should be published in the *Memoirs* of the Royal Astronomical Society, and at the expense of the Admiralty. Mr. Airy has availed himself of his position as custodian of the papers of the late Board of Longitude (which are now stored at the Royal Observatory) to furnish an exact history of this important institution.

As only a portion of this Paper was read, no further mention will be made of it in the present *Notice*. The work will probably be published in the quarto Volume for 1850, and will doubtless prove an important addition to those gratuitous contributions with which the Astronomer Royal has frequently enriched our science, while he has preserved the labours of astronomers deceased from neglect or even total oblivion.

## METIS.

### Observations.

HAMBURG.	Meridian Circle.			(M. C. Rümker.)
1849.	Hamb. M.T.	R.A.	Dec.	
	<sup>h</sup> <sub>h</sub> <sup>m</sup> <sub>m</sub> <sup>s</sup> <sub>s</sub>	<sup>°</sup> <sub>°</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	<sup>°</sup> <sub>°</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	
Aug. 20	12 25 22.0	335 31 44.8	-20 21 52.8	
25	12 0 52.9	334 19 9.0	20 51 4.5	
30	11 36 21.5	333 6 0.0	21 16 45.2	
Sep. 4	11 58.7	331 54 59.4	38 20.7	
5	11 7 7.8	41 12.4	42 8.4	
7	10 57 28.6	331 14 16.4	49 7.0	
9	47 52.5	330 48 8.0	21 55 15.1	
13	28 44.7	329 56 57.5	22 4 55.6	
15	19 32.3	329 36 45.0	8 46.3	
19	10 1 3.9	328 55 26.1	13 23.1	
20	9 56 30.7	46 6.7	14 5.9	
21	51 39.4	37 12.6	14 27.0	
23	43 1.5	20 38.7	14 35.6	
24	38 35.2	13 1.8	14 34.7	
25	34 10.7	328 5 51.5	14 7.2	
26	29 47.5	327 59 1.4	13 23.0	
27	25 26.4	52 43.1	12 43.7	
Oct. 1	9 8 20.3	327 32 1.3	-22 7 25.6	

## LIVERPOOL.

8½-inch Achromatic.

(Mr. Hartnup.)

	Greenwich M.T.				R.A.		N.P.D.		Comp <sup>d</sup> —Obs <sup>d</sup> .		Stars.	
	h	m	s	°	h	m	s	°	R.A.	N.P.D.	R.A.	B.A.C.
1849.												
Sep. 22	10	1	16.0	21	53	53.88	112	14	36.3	—0.46	—14.7	7724
Oct. 14	8	27	57.4	49	2.71	111	30	30.6	—0.43	—18.0	7750, 7724	
20	8	5	36.2	50	16.92	111	4	8.4	—0.17	—15.9	—	—
21	8	1	58.8	50	35.70	110	59	14.2	—0.36	—15.7	—	—
28	7	37	24.0	21	53	32.63	110	21	4.1	—0.36	—13.1	—

"The places of the stars are taken from the Catalogue cited. The observed places are corrected for refraction and parallax. The computed places were deduced from Mr. Graham's Ephemeris, published in the *Monthly Notices*, vol. ix. No. 8."

*Ephemeris at Greenwich Mean Midnight. By Mr. Graham.*

	R.A.				N.P.D.			R.A.				N.P.D.	
	h	m	s	°	h	m		h	m	s	°	h	m
1849.								1849.					
Oct. 31	21	55	18.67	110	1	23.7		Dec. 1	22	24	1.81	105	54
Nov. 1		55	55.25	109	55	1.7		2		25	14.20	45	21.2
2		56	33.31		48	32.7		3		26	27.42	35	49.0
3		57	12.81		41	56.6		4		27	41.46	26	11.9
4		57	53.74		35	13.8		5		28	56.30	16	29.9
5		58	36.08		28	24.1		6		30	11.95	105	6
6	21	59	19.80	21	27.5			7		31	28.37	104	56
7	22	0	4.88		14	24.3		8		32	45.56	46	55.0
8		0	51.31	109	7	14.4		9		34	3.49	36	53.8
9		1	39.05	108	59	58.1		10		35	22.17	26	48.0
10		2	28.10		52	35.4		11		36	41.58	16	37.6
11		3	18.44		45	6.1		12		38	1.70	104	6
12		4	10.04		37	30.5		13		39	22.52	103	56
13		5	2.88		29	48.7		14		40	44.02	45	39.2
14		5	56.94		22	0.7		15		42	6.20	35	10.8
15		6	52.21		14	6.6		16		43	29.03	24	38.1
16		7	48.65	108	6	6.4		17		44	52.51	14	1.1
17		8	46.24	107	58	0.3		18		46	16.61	103	3
18		9	44.97		49	48.3		19		47	41.34	102	52
19		10	44.81		41	30.5		20		49	6.66	41	44.9
20		11	45.74		33	6.9		21		50	32.58	30	51.3
21		12	47.75		24	37.6		22		51	59.07	19	53.7
22		13	50.79		16	2.8		23		53	26.11	102	8
23		14	54.87	107	7	22.4		24		54	53.72	101	57
24		15	59.94	106	58	36.6		25		56	21.85	46	37.8
25		17	5.99		49	45.5		26		57	50.52	35	24.9
26		18	13.01		40	48.9		27	22	59	19.71	24	8.2
27		19	20.96		31	47.2		28	23	0	49.40	12	47.9
28		20	29.84		22	40.1		29		2	19.59	101	1
29		21	39.62		13	28.0		30		3	50.27	100	49
Nov. 30	22	22	50.28	106	4	10.8		Dec. 31	23	5	21.44	100	38

## Metis.

		R.A.			N.P.D.					R.A.			N.P.D.		
1880.		h	m	s	°	'	"	1880.		h	m	s	°	'	"
Jan.	1	23	6	53.08	100	26	51.4	Feb.	14	0	20	20.96	91	14	35.4
	2		8	25.18		15	13.6		15		22	8.12	91	1	24.7
	3		9	57.75	100	3	32.4		16		23	55.55	90	48	13.3
	4		11	30.76	99	51	47.9		17		25	43.23		35	1.3
	5		13	4.23		40	0.1		18		27	31.17		21	48.8
	6		14	38.14		28	9.1		19		29	19.37	90	8	35.9
	7		16	12.48		16	14.8		20		31	7.82	89	55	22.6
	8		17	47.26	99	4	17.4		21		32	56.52		42	9.0
	9		19	22.44	98	52	17.0		22		34	45.47		28	55.2
	10		20	58.06		40	13.5		23		36	34.67		15	41.1
	11		22	34.08		28	7.0		24		38	24.12	89	2	27.0
	12		24	10.51		15	57.6		25		40	13.82	88	49	12.8
	13		25	47.31	98	3	45.4		26		42	3.77		35	58.7
	14		27	24.52	97	51	30.4		27		43	53.97		22	44.6
	15		29	2.10		39	12.7		28		45	44.42	88	9	30.7
	16		30	40.05		26	52.4	Mar.	1		47	35.12	87	56	17.0
	17		32	18.38		14	29.5		2		49	26.08		43	3.5
	18		33	57.06	97	2	4.0		3		51	17.29		29	50.3
	19		35	36.10	96	49	36.1		4		53	8.75		16	37.6
	20		37	15.48		37	5.9		5		55	0.47	87	3	25.3
	21		38	55.20		24	33.3		6		56	52.44	86	50	13.5
	22		40	35.26	96	11	58.6		7	0	58	44.67		37	2.3
	23		42	15.66	95	59	21.6		8	1	0	37.15		23	51.7
	24		43	56.37		46	42.5		9		2	29.89	86	10	41.9
	25		45	37.38		34	1.4		10		4	22.88	85	57	32.4
	26		47	18.70		21	18.3		11		6	16.12		44	24.6
	27		49	0.32	95	8	33.3		12		8	9.62		31	17.4
	28		50	42.22	94	55	46.4		13		10	3.37		18	11.2
	29		52	24.44		42	57.6		14		11	57.37	85	5	6.1
	30		54	6.99		30	7.1		15		13	51.61	84	52	2.1
	31		55	49.87		17	14.9		16		15	46.11		38	59.4
Feb.	1		57	33.06	94	4	20.9		17		17	40.85		25	58.1
	2	23	59	16.59	93	51	25.4		18		19	35.85	84	12	58.2
	3	0	1	0.41		38	28.3		19		21	31.09	83	59	59.7
	4		2	44.51		25	29.7		20		23	26.58		47	2.8
	5		4	28.90	93	12	29.7		21		25	22.30		34	7.6
	6		6	13.56	92	59	28.3		22		27	18.28		21	14.0
	7		7	58.50		46	25.6		23		29	14.49	83	8	22.3
	8		9	43.71		33	21.6		24		31	10.95	82	55	32.4
	9		11	29.22		20	16.4		25		33	7.66		42	44.4
	10		13	15.01	92	7	10.1		26		35	4.61		29	58.3
	11		15	1.08	91	54	2.8		27		37	1.81		17	14.4
	12		16	47.44		40	54.5		28		38	59.26	82	4	32.5
Feb.	13	0	18	34.07	91	27	45.4	Mar.	29	1	40	56.96	81	51	52.8

1850.	R.A.			N.P.D.			1850.	R.A.			N.P.D.		
	h	m	s	°	'	"		h	m	s	°	'	"
Mar. 30	1	42	54.90	81	39	15.4	April 9	2	2	48.66	79	35	7.9
31		44	53.11		26	40.2	10		4	49.48		23	9.4
April 1		46	51.57		14	7.4	11		6	50.55		79	11 4.0
2		48	50.30	81	1	37.0	12		8	51.88		78	59 1.7
3		50	49.28	80	49	9.1	13	10	53.47		47		2.7
4		52	48.53		36	43.8	14	12	55.32		35		6.9
5		54	48.03		24	21.1	15	14	57.42		23		14.6
6		56	47.80	80	12	1.0	16	16	59.77		78	11	25.7
7	1	58	47.82	79	59	43.8	April 17	2	19	2.37	77	59	40.3
April 8	2	0	48.11	79	47	29.4							

1849.	Log. Δ	Hor. Par.	1849.	Log. Δ	Hor. Par.	1850.	Log. Δ	Hor. Par.
Oct. 31	0.26541	"	Dec. 2	0.34156	"	Jan. 3	0.40280	"
Nov. 1	.26793	4.63	3	.34372	3.89	4	.40444	3 38
2	.27045		4	.34587		5	.40606	
3	.27296		5	.34801		6	.40767	
4	.27547		6	.35013		7	.40926	
5	.27797	4.52	7	.35223	3.81	8	.41084	3.33
6	.28047		8	.35432		9	.41239	
7	.28295		9	.35639		10	.41394	
8	.28543		10	.35845		11	.41546	
9	.28790	4.42	11	.36049	3.74	12	.41697	3.28
10	.29036		12	.36251		13	.41846	
11	.29282		13	.36452		14	.41994	
12	.29526		14	.36651		15	.42140	
13	.29769	4.32	15	.36849	3.67	16	.42284	3.24
14	.30012		16	.37045		17	.42427	
15	.30253		17	.37239		18	.42568	
16	.30493		18	.37431		19	.42707	
17	.30732	4.23	19	.37622	3.61	20	.42845	3.20
18	.30970		20	.37811		21	.42981	
19	.31206		21	.37998		22	.43115	
20	.31442		22	.38184		23	.43248	
21	.31676	4.14	23	.38368	3.55	24	.43379	3.16
22	.31908		24	.38550		25	.43509	
23	.32139		25	.38730		26	.43637	
24	.32369		26	.38909		27	.43763	
25	.32598	4.05	27	.39086	3.49	28	.43888	3.12
26	.32825		28	.39262		29	.44012	
27	.33051		29	.39436		30	.44134	
28	.33275		30	.39608		31	.44254	
29	.33497	3.97	31	.39778	3.43	Feb. 1	.44373	3.09
30	.33718		1850.			2	.44490	
Dec. 1	0.33938		Jan. 1	.39947		3	.44606	
			2	0.40114				

## Observed Diameters of Venus.

	Log. Δ	Hor. Par.	1849.	Log. Δ	Hor. Par.	1849.	Log. Δ	Hor. Par.
Feb. 4	0.44720	"	Mar. 1	.47098	2.90	Mar. 26	.48617	
5	.44833	3.06	2	.47174		27	.48661	
6	.44944		3	.47249		28	.48704	
7	.45054		4	.47324		29	.48746	2.79
8	.45163		5	.47396	2.88	30	.48786	
9	.45269	3.02	6	.47468		31	.48826	
10	.45374		7	.47538		April 1	.48864	
11	.45478		8	.47606		2	.48901	2.78
12	.45581		9	.47674	2.86	3	.48937	
13	.45682	3.00	10	.47740		4	.48971	
14	.45781		11	.47804		5	.49005	
15	.45879		12	.47867		6	.49037	2.77
16	.45975		13	.47929	2.85	7	.49068	
17	.46070	2.97	14	.47990		8	.49098	
18	.46163		15	.48049		9	.49126	
19	.46256		16	.48107		10	.49154	2.77
20	.46346		17	.48164	2.83	11	.49180	
21	.46435	2.94	18	.48220		12	.49205	
22	.46523		19	.48274		13	.49229	
23	.46609		20	.48327		14	.47251	2.76
24	.46694		21	.48379	2.82	15	.49273	
25	.46778	2.92	22	.48429		16	.49293	
26	.46859		23	.48478		April 17	.49312	
27	.46940		24	.48525				
Feb. 28	0.47020		Mar. 25	0.48572	2.80			

"The ellipse is still assumed to be invariable. The calculated places have been corrected for observation, and they are referred to the apparent equinox.

"This ephemeris will enable observers to follow the planet as long as there is the smallest chance of seeing it."

## Observed Diameters of Venus.

LIVERPOOL.

20-foot Equatoreal.

(Mr. Lassell.)

1849, March 16.24	28.675	} Mean 28.866.
	29.130	
	28.753	
	28.995	
	28.775	

Aperture contracted to 20 inches, parallel wire-micrometer by Merz; magnifying power, 366.

"The observations were taken in daylight in order to avoid any error from irradiation, and also that the planet might be seen as near the meridian as practicable.

"Air very tremulous, though not more so than is usual under such circumstances. The edge of *Venus*, however, was sharp between the vibrations. The cusps equal in sharpness. No well-ascertained spots or markings visible."

1849, March 21.216	30.619	} Mean 30.589.
	30.748	
	30.431	
	30.721	
	30.425	

Measures taken with somewhat more difficulty than on the 16th; same power and aperture.

LIVERPOOL.  $8\frac{1}{2}$ -inch Achromatic. (Mr. Hartnup.)

		Parallel-wire Micrometer.				Double-Image Micrometer.			
		G.M.T.	Diameter.	Obs.	Power.	G.M.T.	Diameter.	Obs.	Power.
1849.		<sup>h</sup> <sub>m</sub>	<sup>s</sup>			<sup>h</sup> <sub>m</sub>	<sup>s</sup>		
Feb. 27	6 31	24.66	10	400	6 56	23.38	10	261	
28	5 10	24.69	10	180	5 40	23.62	10	261	
April 30	5 53	55.42	20	180	5 33	55.84	20	261	
Oct. 19	22 0	14.47	20	180	23 42	13.36	20	261	

DURHAM. Fraunhofer Equatoreal. (Rev. R. A. Thompson.)

		Wire Micrometer.		
		Mean of 10 Measures.	Greatest Measured Value.	Least Measured Value
1849.				
April 19	7 <sup>h</sup> 6 <sup>m</sup>	49".43	50".00	48".82
		Double Image Micrometer.		
	7 <sup>h</sup> 36 <sup>m</sup>	48".90	49".33	48".38

*Observed Diameters of Saturn.*

DURHAM. Fraunhofer Equatoreal. (Rev. R. A. Thompson.)

		Double Image Micrometer.		
		Eq. Diam.	Polar	
1848				
Aug. 31	12 <sup>h</sup> 30 <sup>m</sup>	= 18".76	} Means of 10 Measures of each.	
	13 <sup>h</sup> 0 <sup>m</sup>	= 17".09		

*Satellites of Uranus. Observations by Mr. Lassell.*

Satellite I.

	Greenwich M.T.	Position.	Obs.	Distance.	Obs.
1849.	<sup>h</sup> <sub>m</sub>	<sup>o</sup> <sub>'</sub>			
Sept. 17	14 15	189 49	2		
	13 40			30.67	3
19	13 54	132 32	2		
	14 6			25.51	3
Oct. 13	11 15	196 18	3		
	12 35			28.35	4

Satellite II.

	Greenwich M.T.	Position.	Obs.	Distance.	Obs.
1849.	<sup>h</sup> <sub>m</sub>	<sup>o</sup> <sub>'</sub>			
Sept. 17	14 20	147 53	2		
	13 55			43.07	3
19	13 48	87 0	3		
	14 15			28.90	3
Oct. 13	11 37	167 9	3		
	12 1			45.42	4

Sept. 17. II. is rather the brighter; atmosphere unfavourable.

A suspected satellite, very faint and difficult to measure, was observed the same day.

At 14<sup>h</sup> 40<sup>m</sup> G.M.T. Pos<sup>n</sup> 11° 44': 14<sup>h</sup> 30<sup>m</sup> G.M.T. Dist. = 20".5.

**Lassell's Satellite of Neptune. Observations by Mr. Lassell.**

	Greenwich M.T.	Position.	Obs.	Distance.	Obs.	Power.
1849.	<sup>h</sup> <sup>m</sup>	<sup>°</sup> <sup>'</sup>				
Sept. 19	10 10 <sup>h</sup> 2 <sup>m</sup>	20 26 <sup>°</sup>	4			366
	10 25			8.86	1	—
Oct. 13	8 40	36 17	3			—
Nov. 3	8 16 <sup>h</sup> 4 <sup>m</sup>	218 6 <sup>°</sup>	4			—
	8 37 <sup>h</sup> 1 <sup>m</sup>			16 <sup>h</sup> 44 <sup>m</sup>	4	—

Sept. 19. Positions carefully taken, but with difficulty. The distance extremely difficult.

Oct. 13. Sky hazy.

Nov. 3. Sky indifferent, measures difficult; but, from the care employed and the advantage of a recently applied clock motion, considered to be equal in value to former measures taken in more favourable circumstances.

**Goujon's Comet. Observations by Mr. Lassell.**

	Greenwich M.T.	R.A. Star—Comet.	N.P.D. Star—Comet.	No. Obs.
1849.	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>″</sup>	<sup>°</sup> <sup>'</sup> <sup>″</sup>	
Sept. 19	8 51 59 <sup>h</sup> 5 <sup>m</sup> 5 <sup>s</sup>	0 57 <sup>°</sup> 87 <sup>'</sup>		9
	8 51 37 <sup>h</sup> 9 <sup>m</sup> 9 <sup>s</sup>		0 57 <sup>°</sup>	9
22	8 41 35 <sup>h</sup> 5 <sup>m</sup> 5 <sup>s</sup>	—0 33 <sup>°</sup> 54 <sup>'</sup>		7
	9 1 27 <sup>h</sup> 3 <sup>m</sup> 3 <sup>s</sup>		—2 28 <sup>°</sup> 2 <sup>'</sup>	9

"Since the above I have taken several favourable opportunities of looking for the comet, without success. Being situated, as it is, in so bright a portion of the Milky Way that the field was constantly filled with stars from the fifth magnitude downward, I scarcely expected that I should distinguish it. The field of the telescope was as bright as twilight."

**Mean Places for Jan. 1, 1849, of Stars compared by Mr. Lassell with Goujon's Comet.**

LIVERPOOL.		Equatoreal.		(Mr. Hartnup.)
Day of Comp. with Comet.	Mag.	Mean R.A.	Mean N.P.D.	No. Obs.
1849.		<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>″</sup>	
Sept. 11	6	18 9 8 <sup>h</sup> 19 <sup>m</sup> 8 <sup>s</sup>	28 51 5 <sup>°</sup> 4 <sup>'</sup> 4 <sup>″</sup>	2
17	8 <sup>h</sup> 1 <sup>m</sup> 2 <sup>s</sup>	28 41 15	31 14 36 <sup>°</sup> 6 <sup>'</sup>	3
19	8 <sup>h</sup> 1 <sup>m</sup> 2 <sup>s</sup>	35 13 56	32 7 7 <sup>°</sup> 1 <sup>'</sup>	3
22	8 <sup>h</sup> 1 <sup>m</sup> 2 <sup>s</sup>	18 43 4 <sup>h</sup> 58 <sup>m</sup> 8 <sup>s</sup>	33 25 32 <sup>°</sup> 4 <sup>'</sup> 4 <sup>″</sup>	2
				6079, 6289, 6500
				....
				....
				....

**Observations of Gambart's (Biela's) Comet. By T. Maclear, Esq.**  
Her Majesty's Astronomer at the Cape of Good Hope.

"The observations of this comet were made with the 46-inch achromatic by Dollond, mounted on its old equatoreal stand, and armed with a position-micrometer, by Simms, having three flat wires instead of spider-lines. Two of these wires are parallel and moveable by micrometer screws, one revolution of which is equal to 44<sup>h</sup> 53<sup>m</sup> 15<sup>s</sup> of a great circle. The third is fixed and perpendicular to the moveable wires. The breadth of each wire is about 19<sup>h</sup> 15<sup>m</sup> 15<sup>s</sup>."

"The moveable wires were adjusted parallel to the equator by causing stars near the equator to describe a narrow space between their proximate edges."

"No artificial light was used in observation, except for the purpose of counting the revolutions: this was managed by rotating the small illuminating reflector on the axis of its support.

"The telescope being clamped, the differences in right ascension were the differences in time between the disappearances behind the fixed wire, corrected for the rate of the chronometer; and the apparent differences in declination were measured by placing one or other of the edges of one moveable wire on the apparent centre of the star, and the centre of the other moveable wire on the centre of the comet. The edges were placed on the centre of the star in alternate order, generally, to eliminate the breadth of the wire. When time and distance permitted, both objects were measured by the same screw, and in all cases, as near as possible to the fixed wire.

"This comet is perhaps the most interesting on record, on account of the appendage, which was probably a portion of the original mass. The observations of the appendage are distinguished by the letter *a*. After the 25th of February this body was compared occasionally with the principal mass. These comparisons are given by themselves; they are somewhat uncertain because there was no obvious centre to select for the wire, and the outline was very faint. After the 18th of March no measures of it were attempted.

"The heading to each column is sufficiently explicit. The numbers in the columns, R.A., N.P.D., express *geocentric* positions; viz. the observed positions corrected for parallax and refraction. For the computation of parallax the distances stated in the *Nautical Almanac* for 1849, page xvi. &c. were employed.

"The last column gives the initials of the observer. W. M. denotes William Mann; H. C., Hubert Campion, R.N.; T. M., Thomas Maclear.

"A Catalogue is added containing the positions of the stars compared with the comet, all of which, excepting two, were determined by the 10-foot transit instrument and 6-foot mural circle. Nos. 14 and 15 were observed with the 46-inch equatoreal instrument, erected in the year 1847, by the method of differences. The star is identified by its number. The positions are the mean places January 1, 1846, and the precessions refer to the same epoch.\*

Date.	No.	Cape M.T.	R.A.	N.P.D.	Obs.
1846.		h m s	h m s	° ' "	
Feb. 18 (a)	1	8 40 34.3	2 12 52.98		6 W. M.
	...	40 44.8	13 3.54		6
	(a)	55 2.7		95 15 21.6	4
	...	58 38.0		20 43.3	4
19 (a)	2	27 6.9	2 17 58.02		6 W. M.
	...	27 17.6	18 8.80		6
	...	43 1.5		95 36 5.1	4
	(a)	8 43 34.4		30 32.4	10

\* Mr. Maclear has sent his observations in fuller detail than they are given here; all the *results* are published, and in case of doubt the original papers can easily be referred to.

*Observations of Gambart's (Biela's) Comet.*

Date. 1846.	No.	Cape M.T. h m s	R.A. h m s	N.P.D. ° ' "	Obs.	
Feb. 19 (a)	2	9 5 22.2	2 18 6.12		4	W. M.
...	...	9 5 33.1	18 17.15		4	
20 (a)	3	8 7 23.5	2 23 7.72		6	W. M.
...	...	7 34.4	23 18.64		6	
(a)	...	21 44.2		95 45 59.1	6	
...	...	24 51.2		51 43.3	6	
25 (a)	4	35 3.8	2 51 1.81		8	H. C.
...	...	8 35 19.2	51 17.30		8	
(a)	..	9 13 41.6		97 11 15.4	8	
...	...	9 18 20.0		18 33.9	8	
26	5	8 38 30.4	2 57 14.99		8	H. C.
...	...	8 59 16.8		97 36 3.4	8	
...	...	9 16 15.6	57 24.50		8	
Mar. 1	6	50 13.0	3 16 14.25		3	T. M.
...	...	9 50 16.3		98 32 40.0	3	
4	10	8 21 59.6	3 35 47.50	99 29 40.0	3	T. M.
...	9	8 23 26.1	35 48.03	29 40.7	4	
...	9	9 14 47.3	36 2.28	30 26.4	6	
...	10	9 14 47.3	36 1.77	30 22.0	6	
...	9	10 10 54.6	36 17.60	31 1.1	2	
...	10	10 10 54.6	36 17.81	30 58.0	2	
5	11	8 56 4.5	3 42 53.54		2	T. M.
...	12	8 56 4.5	42 53.79		2	
...	14	8 56 4.5	42 54.71		2	
...	11	9 14 23.4	42 57.44		2	
...	12	9 14 23.4	42 56.75		2	
...	14	9 43 7.3	43 6.74	99 49 45.3	8	
...	14	10 10 8.7	43 14.85	50 20.9	2	
...	15	10 10 8.7	43 14.10	50 28.0	2	
6	16	7 52 46.1	3 49 41.98	100 8 6.8	6	T. M.
...	17	8 26 50.0		8 48.1	10	
...	...	9 19 44.9	50 6.07		15	
...	...	42 59.0		9 34.9	5	
...	...	43 50.1	50 12.98		11	
...	...	9 49 29.1		9 43.8	4	
...	...	10 16 29.6		9 43.3	6	
...	...	17 6.9	50 22.72		11	
...	...	10 31 29.9		9 53.6	2	
Mar. 7	18	7 52 11.0	3 56 54.85		4	T. M.
...	19	7 53 36.6	56 54.55		5	
...	...	8 24 9.8		100 27 35.9	12	
...	...	8 32 25.2	57 6.97		9	
...	18	9 45 15.5	57 32.42		4	
...	19	9 55 7.0	3 57 32.20	100 28 58.2	8	

*Observations of Gambart's (Biela's) Comet.*

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Date. 1846.	No.	Cape M.T. h m s	R.A. h m s	N.P.D. ° ' "	Obs.	
Mar. 8	20	7 59 25.3	4 4 19.20	100 46 43.7	6	T. M.
	...	8 36 6.9	4 30.81	47 5.1	8	
	21	8 36 6.9	4 30.96	47 5.2	8	
	20	9 15 23.8	4 43.94	47 42.3	10	
	21	15 23.8	4 43.97	47 36.8	10	
	20	50 43.9	4 54.15	47 54.3	6	
	21	9 50 50.2	4 55.13	46 56.5	4	
	20	10 21 1.1	5 3.35		10	
	20	10 42 48.0		48 38.0	4	
9	22	7 41 59.0	4 11 47.18		5	T. M.
	...	7 54 12.5		101 6 36.5	6	
	...	8 10 3.8	11 56.15		6	
	...	46 42.4		6 57.5	6	
	...	8 58 5.4	12 11.82		6	
	...	9 11 6.6		7 15.1	6	
	...	30 11.9	12 22.32		6	
	...	43 34.3		7 46.7	6	
	...	9 57 22.4	12 31.11		6	
10	23	8 10 40.1	4 19 39.73		6	T. M.
	24	10 40.1	19 39.18		6	
	23	42 33.8	19 49.10	101 24 41.9	8	
	24	8 48 30.0	19 50.31	24 40.7	6	
	23	9 29 9.7	20 3.02		9	
	24	29 9.7	20 2.81		9	
	23	31 11.5		25 19.2	8	
	24	9 31 11.5		25 20.4	8	
	24	10 24 44.9	20 20.07	25 55.1	8	
11	25	8 18 18.2	4 27 30.16		14	T. M.
	...	8 21 50.7	27 31.47	101 42 28.2	12	
	...	9 5 5.6	27 46.19	43 3.0	10	
	26	10 1 54.0	28 4.35	43 49.8	10	
	25	10 35 35.5		44 14.3	2	
12	27	8 13 4.9	4 35 27.51		6	T. M.
	...	33 17.7		102 0 24.6	8	
	...	8 34 26.4	35 34.03		10	
	...	9 27 41.8	35 51.82	1 2.8	12	
	...	10 1 39.2	36 3.34	1 30.3	6	
13	28	8 0 58.6	4 43 29.02	102 17 3.2	12	T. M.
	29	0 58.6	43 28.72	17 4.2	12	
	28	52 24.4	43 46.56	17 40.0	10	
	29	8 52 24.4	43 46.32	17 41.2	10	
	28	9.35 32.4	44 0.87	18 7.9	10	
	29	9 35 32.4	44 0.60	18 8.8	10	
Mar. 14	30	8 40 38.1	4 51 54.56	102 34 6.0	8	H. C.

*Observations of Gambart's (Biela's) Comet.*

Date. 1846.	No.	Cape M.T. h m s	R.A. h m s	N.P.D. ° ' "	Obs.
Mar. 14	30	9 8 55.8	4 52 5.20	102 34 17.7	8
	...	9 47 36.5	52 18.27	34 38.8	8
15	32	7 52 4.2		102 48 28.6	2 T. M.
	...	7 52 7.3	4 59 58.98		3
	...	8 24 38.0	5 0 11.15	48 57.0	4
	...	8 59 3.1	0 22.06		6
	31	9 1 19.8	0 22.84		4
	31	8 20.9	0 26.40		3
	32	8 20.9	0 26.17		3
	...	27 56.5		50 0.0	8
	...	39 35.0	0 36.64		6
	...	47 31.8		50 18.7	6
	...	9 55 58.7	0 42.22		5
17	33	8 8 3.8	5 17 2.34		6 T. M.
	...	11 38.6		103 17 55.2	4
	λ	30 25.7	17 10.26	17 58.1	2
	...	8 30 25.7	17 10.59	18 0.0	2
	...	9 0 58.4	17 21.17	18 23.0	12
	...	9 42 16.6	17 35.92	18 37.0	12
	...	10 13 34.0	17 46.74	18 58.3	9
18	34	7 49 10.6	5 25 31.64		6 T. M.
	...	7 58 59.7		103 30 35.3	6
	...	8 10 48.1	25 39.35		4
	...	8 35 27.6	25 47.70	30 55.1	8
	36	8 35 27.6	25 47.69	30 51.9	8
	...	9 15 3.8	26 2.59	31 12.8	10
	35	9 45 47.2	26 13.13	31 25.8	10
	36	10 7 35.1	26 21.25	31 39.6	6
19	37	7 42 45.2	5 34 9.28	103 42 15.0	12 T. M.
	...	8 22 5.7	34 23.37	42 29.6	8
	...	9 41 42.9	34 52.29	43 8.9	10
20	38	8 32 16.9	5 43 10.01	103 53 25.4	10 H. C.
	39	8 32 16.9	43 10.10	53 17.2	10
	38	9 43 38.9	43 35.05	53 50.9	10
	39	9 43 38.9	43 35.18	53 48.8	10
21	40	8 20 26.1	5 51 50.35	104 2 44.3	6 T. M.
	41	42 8.8		2 49.0	4
	41	8 48 23.0	52 1.34		4
	42	9 7 14.9	52 7.40	2 56.5	4
	41	38 3.5	52 18.64	3 8.1	10
	42	9 38 3.5	52 18.75	3 7.4	10
	41	10 22 41.5	52 34.63	3 26.8	10
	42	10 22 41.5	5 52 34.52	3 29.0	10
Mar. 23	43	8 9 4.8	6 9 16.02	104 18 5.6	4 T. M.

*Observations of Gambart's (Biela's) Comet.*

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Date. 1846.	No.	Cape M.T.	R.A.	N.P.D.	Obs.	
		<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>		
Mar. 23	44	8 9 4.8	6 9 16.35	104 18 8.3	4	T.M.
	43	8 29 5.3	9 24.03	18 3.2	2	
	43	9 6 53.3	9 37.80	18 20.6	12	
	44	9 6 53.3	9 37.62	18 19.9	12	
	43	10 8 59.8	9 59.03	18 35.8	12	
	44	10 8 59.8	9 59.28	18 36.0	12	
24	45	8 38 2.7	6 18 10.21		5	T.M.
	46	38 2.7	18 10.31		5	
	46	49 21.6		104 23 52.8	4	
	45	8 55 59.2		23 48.3	4	
	45	9 20 26.3	18 27.05		6	
	45	23 20.9		23 56.9	4	
	46	9 37 3.5	18 33.07	24 5.7	4	
	45	10 6 10.0	18 43.43	24 5.3	4	
	45	33 24.5	18 53.39	24 22.2	6	
	46	10 53 23.9	19 0.04	24 17.1	6	
26	46 <i>bis</i>	8 30 57.4	6 35 28.79		4	H. C.
	...	48 3.0			12	
	...	8 59 53.7	35 38.72		13	
	...	9 14 20.8			2	
	...	9 33 12.8	35 51.32		10	
27	47	8 14 57.5	6 43 58.68		10	T. M.
	...	8 30 26.8		104 33 50.0	10	
	...	9 6 21.9	44 16.30		10	
	...	9 35 13.5		33 45.0	10	
	...	10 13 2.4	44 40.84	33 56.4	10	
	48	10 13 2.4	44 41.16	34 0.1	10	
28	49	8 2 5.7	6 51 22.80	104 34 47.8	4	H. C.
	49	9 14 12.2		34 53.7	8	
	49	16 57.3	52 50.01		10	
	50	22 38.8		34 52.0	6	
	50	9 25 16.0	52 52.21		7	
	49	10 25 45.6	53 12.75	34 52.9	10	
	50	10 25 45.6	53 12.01	34 41.2	10	
29	51	8 55 48.0	7 1 5.11	104 34 35.7	10	T. M.
	52	8 55 48.0	1 5.07	34 38.0	10	
	51	10 8 8.2	1 27.92	34 38.4	8	
	52	10 8 8.2	1 28.09	34 45.5	8	
Mar. 31	54	8 36 20.2	7 17 23.40	104 31 9.8	8	T. M.
	54	9 15 58.1	17 37.34	31 2.6	6	
	53	32 39.8	17 44.32		2	
	54	32 39.8	17 44.46		2	
	53	37 38.2	17 44.47		3	
	54	37 38.2	17 44.56		3	

*Observations of Gambart's (Biela's) Comet.*

Date. 1846.	No.	Cape M.T. h m s	R.A. h m s	N.P.D. ° ' "	Obs.	
Mar. 31	53	9 51 53.9		104 30 54.4	8	T. M.
	54	10 6 8.2		31 4.0	8	
	53	18 33.0	7 17 57.78		6	
	54	18 33.0	17 57.41		6	
	54	10 31 21.4		30 55.3	5	
April 2	55	8 2 49.1	7 33 3.69		4	T. M.
	...	8 59 13.5	33 24.83		11	
	...	9 24 18.9		104 23 46.0	6	
3	...	9 37 23.6	33 38.19		7	T. M.
	56	7 48 53.6	7 40 43.73		4	
	57	7 48 53.6	40 43.78		4	
	56	8 9 51.4		104 19 50.9	2	
	57	9 51.4		19 50.2	2	
	56	19 49.0	40 54.40		5	
	57	19 49.0	40 54.67		5	
	56	43 15.2	41 1.93		2	
	57	43 15.2	41 2.35		2	
	56	53 51.6	41 6.76		8	
	57	8 53 51.6	41 7.13		8	
	56	9 19 2.0	41 14.63	18 36.6	2	
	57	9 19 2.0	7 41 15.06	104 18 36.1	2	

*Differences in Right Ascension and North Polar Distance of the two Comets. The smaller one precedes, and is to the north of the larger.*

Date.	Obs.	Cape M.T. h m s	Diff. R.A. s	Diff. N.P.D. ' "
Feb. 26	6	9 23 48.4	15.40	
	8	9 31 4.3		6 53.2
Mar. 3	2	7 48 11.7	17.55	7 39.7
	5	7 49 50.3	23.31	7 20.5
	17	7 44 23.0	40.37	
	3	7 51 43.2		9 8.0
	18	7 33 4.1	36.43	
	2	7 37 17.9		8 52.1

*Mean Places of the Stars, for January 1, 1846, compared with Gambart's (Biela's) Comet.*

No.	Mag.	R.A. h m s	Ann. Prec.	Obs.	N.P.D. ° ' "	Ann. Prec.	Obs.
1	7	2 11 56.71	+3.006	4	95 3 25.3	-16.82	4
2	9	17 24.21	2.999	4	26 49.0	16.55	5
3	9	22 44.72	2.992	5	43 7.7	16.28	5
4	8	51 55.74	2.955	4	97 13 51.9	14.67	4
5	10	2 56 48.03	2.948	4	97 28 1.0	14.37	3
6	8	3 15 46.53	2.923	6	98 20 14.3	13.17	9
7	8	29 17.86	2.898	4	99 17 6.7	12.25	3
8		31 54.73	2.901	1	0 47.8	12.07	2
9	8	3 32 44.14	+2.891	5	99 32 30.6	-12.01	2

Observations of Gambart's (Biela's) Comet.

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No.	Mag.	R.A. <small>h m s</small>	Ann. Pre.	Obs.	N.P.D. <small>° ' "</small>	Ann. Pre.	Obs.
10	7½	3 38 31.39	+ 2.888	7	99 29 36.2	- 11.60	10
11	8½	39 12.15	2.879	6	55 29.3	11.56	4
12	8½	39 26.60	2.880	4	52 4.3	11.54	3
14	10	42 53.59	2.881		43 6.7	11.29	
15	7	46 29.32	2.879		99 42 52.4	11.03	
16	6	49 14.89	2.868	8	100 12 8.8	10.83	5
17	8	50 15.60	2.869	5	8 54.5	10.75	5
18	10	56 53.92	2.858	4	27 23.7	10.25	1
19	7	3 59 40.87	2.858	14	24 43.5	10.05	6
20	9	4 4 50.96	2.846	6	51 55.5	9.65	5
21	7	6 10.45	2.847	7	46 56.7	9.55	7
22	8½	12 15.94	2.840	9	100 58 11.5	9.08	6
23	9	18 43.97	2.824	5	101 31 27.4	8.57	6
24	7	20 31.76	2.824	9	28 23.6	8.43	5
25	8½	28 13.44	2.811	6	53 40.0	7.81	4
26	7½	29 9.52	2.818	4	101 35 4.5	7.74	5
27	8½	34 36.95	2.806	7	102 0 38.3	7.29	5
28	8	42 30.43	2.795	6	18 53.1	6.65	7
29	7½	44 30.33	2.797	7	12 45.6	6.48	7
30	6	4 52 46.48	2.780	10	46 7.5	5.79	10
31	7	5 0 14.93	2.780	11	41 41.9	5.16	6
32	7	0 41.78	2.777	7	102 47 43.0	5.13	5
Leporis λ	7½	12 28.87	2.760	5	103 20 25.3	4.12	2
33	7½	18 33.59	2.760	12	16 13.9	3.60	7
34	9	25 16.25	2.757	5	20 15.9	2.02	6
35	8½	26 35.89	2.749	4	38 37.6	2.91	5
36	9	26 51.16	2.755	5	24 1.8	2.88	6
37	8	33 42.00	2.745	7	46 3.9	2.29	5
38	9	41 26.47	2.745	7	42 36.9	1.62	6
39	8	44 32.65	2.742	4	103 50 51.0	1.35	4
40	8	50 45.75	2.732	9	104 13 52.3	0.80	6
41	8½	51 49.17	2.732	6	13 26.2	0.71	5
42	9	5 53 20.26	2.737	5	1 40.9	- 0.58	5
43	8	6 8 56.40	2.728	10	22 54.1	+ 0.79	5
44	8	11 34.97	2.730	5	18 13.6	1.02	5
45	7½	18 1.29	2.728	11	25 20.6	1.58	5
46	7½	18 10.27	2.730	3	20 2.8	1.59	5
46 bis	8	34 47.43	2.730	7			
47	8	43 46.44	2.729	8	33 56.7	3.81	5
48	8½	46 29.82	2.734	6	25 4.1	4.05	3
49	8½	51 0.63	2.730	7	37 4.7	4.43	5
50	7½	52 2.04	2.727	7	45 20.8	4.52	5
51	8	6 58 32.07	2.732	7	38 32.2	5.07	5
52	8	7 3 20.06	2.737	7	31 12.1	5.48	5
53	8½	17 4.73	2.745	9	26 35.9	6.63	5
54	8	18 4.49	2.743	5	35 4.2	6.71	7
55	8½	33 28.14	2.758	6	17 29.5	7.96	5
56	8½	40 21.21	2.759	8	24 27.4	8.51	5
57	8½	7 41 54.68	+ 2.764	4	104 14 0.6	+ 8.63	4

*Observations of Gambart's (Biela's) Comet.*

Date. 1846.	No.	Cape M.T. h m s	R.A. h m s	N.P.D. ° ' "	Obs.	
Mar. 31	53	9 51 53.9		104 30 54.4	8	T.M.
	54	10 6 8.2		31 4.0	8	
	53	18 33.0	7 17 57.78		6	
	54	18 33.0	17 57.41		6	
	54	10 31 21.4		30 55.3	5	
April 2	55	8 2 49.1	7 33 3.69		4	T.M.
	...	8 59 13.5	33 24.83		11	
	...	9 24 18.9		104 23 46.0	6	
	...	9 37 23.6	33 38.19		7	
	3	56	7 48 53.6	7 40 43.73	4	T.M.
		57	7 48 53.6	40 43.78	4	
		56	8 9 51.4	104 19 50.9	2	
		57	9 51.4	19 50.2	2	
		56	19 49.0	40 54.40	5	
		57	19 49.0	40 54.67	5	
		56	43 15.2	41 1.93	2	
		57	43 15.2	41 2.35	2	
		56	53 51.6	41 6.76	8	
		57	8 53 51.6	41 7.13	8	
		56	9 19 2.0	41 14.63	18 36.6	2
		57	9 19 2.0	7 41 15.06	104 18 36.1	2

*Differences in Right Ascension and North Polar Distance of the two Comets. The smaller one precedes, and is to the north of the larger.*

Date.	Obs.	Cape M.T. h m s	Diff. R.A. "	Diff. N.P.D. "
Feb. 26	6	9 23 48.4	15.40	
	8	9 31 4.3		6 53.2
Mar. 3	2	7 48 11.7	17.55	7 39.7
	5	7 49 50.3	23.31	7 20.5
	17	7 44 23.0	40.37	
	3	7 51 43.2		9 8.0
	18	7 33 4.1	36.43	
	2	7 37 17.9		8 52.1

*Mean Places of the Stars, for January 1, 1846, compared with Gambart's (Biela's) Comet.*

No.	Mag.	R.A. h m s	Ann. Prec.	Obs.	N.P.D. ° ' "	Ann. Prec.	Obs.
1	7	2 11 56.71	+3.006	4	95 3 25.3	-16.82	4
2	9	17 24.21	2.999	4	26 49.0	16.55	5
3	9	22 44.72	2.992	5	43 7.7	16.28	5
4	8	51 55.74	2.955	4	97 13 51.9	14.67	4
5	10	2 56 48.03	2.948	4	97 28 1.0	14.37	3
6	8	3 15 46.53	2.923	6	98 20 14.3	13.17	9
7	8	29 17.86	2.898	4	99 17 6.7	12.25	3
8		31 54.73	2.901	1	0 47.8	12.07	2
9	8	3 32 44.14	+2.891	5	99 32 30.6	-12.01	2

Observations of Gambart's (Biela's) Comet.

15

No.	Mag.	R.A.			Ann. Pre.	Obs.	N.P.D.	Ann. Pre.	Obs.
		<sup>h</sup>	<sup>m</sup>	<sup>s</sup>			<sup>°</sup>		
10	7½	3	38	31.39	+ 2.888	7	99 29 36.2	- 11.60	10
11	8½	39	12.15		2.879	6	55 29.3	11.56	4
12	8½	39	26.60		2.880	4	52 4.3	11.54	3
14	10	42	53.59		2.881		43 6.7	11.29	
15	7	46	29.32		2.879		99 42 52.4	11.03	
16	6	49	14.89		2.868	8	100 12 8.8	10.83	5
17	8	50	15.60		2.869	5	8 54.5	10.75	5
18	10	56	53.92		2.858	4	27 23.7	10.25	1
19	7	3	59	40.87	2.858	14	24 43.5	10.05	6
20	9	4	4	50.96	2.846	6	51 55.5	9.65	5
21	7	6	10.45		2.847	7	46 56.7	9.55	7
22	8½	12	15.94		2.840	9	100 58 11.5	9.08	6
23	9	18	43.97		2.824	5	101 31 27.4	8.57	6
24	7	20	31.76		2.824	9	28 23.6	8.43	5
25	8½	28	13.44		2.811	6	53 40.0	7.81	4
26	7½	29	9.52		2.818	4	101 35 4.5	7.74	5
27	8½	34	36.95		2.806	7	102 0 38.3	7.29	5
28	8	42	30.43		2.795	6	18 53.1	6.65	7
29	7½	44	30.33		2.797	7	12 45.6	6.48	7
30	6	4	52	46.48	2.780	10	46 7.5	5.79	10
31	7	5	0	14.93	2.780	11	41 41.9	5.16	6
32	7	0	41.78		2.777	7	102 47 43.0	5.13	5
Leporis λ	7½	12	28.87		2.760	5	103 20 25.3	4.12	2
33	7½	18	33.59		2.760	12	16 13.9	3.60	7
34	9	25	16.25		2.757	5	20 15.9	2.02	6
35	8½	26	35.89		2.749	4	38 37.6	2.91	5
36	9	26	51.16		2.755	5	24 1.8	2.88	6
37	8	33	42.00		2.745	7	46 3.9	2.29	5
38	9	41	26.47		2.745	7	42 36.9	1.62	6
39	8	44	32.65		2.742	4	103 50 51.0	1.35	4
40	8	50	45.75		2.732	9	104 13 52.3	0.80	6
41	8½	51	49.17		2.732	5	13 26.2	0.71	5
42	9	5	53	20.26	2.737	5	1 40.9	-0.58	5
43	8	6	8	56.40	2.728	10	22 54.1	+0.79	5
44	8	11	34.97		2.730	5	18 13.6	1.02	5
45	7½	18	1.29		2.728	11	25 20.6	1.58	5
46	7½	18	10.27		2.730	3	20 2.8	1.59	5
46 bis	8	34	47.43		2.730	7			
47	8	43	46.44		2.729	8	33 56.7	3.81	5
48	8½	46	29.82		2.734	6	25 4.1	4.05	3
49	8½	51	0.63		2.730	7	37 4.7	4.43	5
50	7½	52	2.04		2.727	7	45 20.8	4.52	5
51	8	6	58	32.07	2.732	7	38 32.2	5.07	5
52	8	7	3	20.06	2.737	7	31 12.1	5.48	5
53	8½	17	4.73		2.745	9	26 35.9	6.63	5
54	8	18	4.49		2.743	5	35 4.2	6.71	7
55	8½	33	28.14		2.758	6	17 29.5	7.96	5
56	8½	40	21.21		2.759	8	24 27.4	8.51	5
57	8½	7	41	54.68	+ 2.764	4	104 14 0.6	+ 8.63	4

the satellite left the disc. Something of this nature we have always observed to accompany a transit of this satellite. The first and fourth satellites we have also seen black or dusky on the disc, but the former has once or twice crossed without our detecting any change. The spots are always less than the shadows, but have appreciable diameters, and make their appearance after the entrance of the satellite upon the limb of *Jupiter*. Changes of relative brightness are constantly going on; the feeblest, on the average, being the fourth, and the brightest usually the third.

"It would be well, as soon as *Jupiter* reaches a convenient position, say during the ensuing winter and in the spring of 1850, for observers generally to record their estimates of the relative brightness of the satellites as often as possible. The labour of doing this will be but trifling, and may lead to the discovery of the laws of these singular phenomena.

"We have observed Schweitzer's comet twice since its reappearance.

"From the circles of the great equatoreal compared with B. A. C. No. 1634, we have:—

Cambridge M. T.				Comet's R.A. 1849 <sup>o</sup> .				Comet's Decl. 1849 <sup>o</sup> .			
1849.	h	m	s	h	m	s		°	'	"	
Aug. 24	15	37	30	4	45	0 <sup>·</sup> 4		— 27	14	14	
	26	15	38 42	4	41	5 <sup>·</sup> 4		— 27	17	45	

"With the micrometer we have the following places:—

Cambridge M. T.							
1849.	h	m	s	Comet follows * in	°	'	"
Aug. 24	15	37	30	Comet N. of *	by	7	36 <sup>·</sup> 5
	26	15	38 42	precedes * by	3	20 <sup>·</sup> 35	N. of * by 4 51

\* is Lacaille 1613, whose place seems to be erroneous in N. P. D.

"The star Lalande 9167, of the 7·8 magnitude, is missing."

The Astronomer Royal exhibited an instrument for performing arithmetical multiplications and divisions, constructed under the direction of William Bell, Esq., Coronation Road, Bristol. The President remarked, that for mere exhibition of the significant figures produced by a single multiplication or division, to a certain degree of accuracy, nothing could be more convenient than the common sliding rule containing two similar scales, one fixed and the other moveable, in which the lengths corresponding to the numbers represented are the logarithms of those numbers corresponding to a certain modulus. In the scales of this kind in common use at the Royal Observatory, the distance from 1 to 10 upon the scale is about 12 inches; and with these dimensions, a product or quotient will be accurate, with the roughest degree of attention, to  $\frac{1}{300}$  part; an accuracy which suffices for a vast amount of the small calculations in an observatory. And with proper scales for trigonometrical functions, the problems of plane and spherical trigonometry can in most cases be easily solved. These inconveniences, however,

attend it: 1st. It cannot be conveniently applied to multiply three or more quantities, or in general to exhibit a product of even two which is given in a different denomination; as when a sine is given by the product of two tangents: this failure, however, may usually be remedied by the use of two parallel sliders. 2dly. When used to multiply numbers, it gives no information as to the place of the decimal point in the product. It is to remove some of these inconveniences, but especially the last, that Mr. Bell has constructed his instrument.

The logarithmic spaces in Mr. Bell's machine are arranged upon a circle, a single series of numbers from 1 to 10 occupying the entire circumference. This construction, as is well known, may be used in the same way as the common sliding rule; but, like it, it gives no information as to the decimal point. But the revolving circle is connected by toothed wheel-work with two smaller circles, each of which performs one revolution for ten revolutions of the principal circle, and each of which has upon its circumference ten series of logarithmic numbers. These small circles, then, give us the means of defining the decimal place, in multiplicand, in multiplier, and in product. Thus, the successive figures 1 upon one circumference may stand for .00001, .0001, .001, .01, .1, 1, 10, 100, 1000, 10000. The rotating index of each circle is adjustable; there are also adjustable indices on the fixed frame. Suppose, then, we had to multiply 27.42 by 332.6, we should, both in the principal circle and in one of the smaller circles, set the 1 of the moveable circle or index to 27.42 on the fixed circle; but there would be this difference, that on the principal circle we have no respect to the decimal point, whereas on the smaller circle we should set to the 2742 following the 10. Then for 332.6 we should turn the principal circle from 1 to 3326, but we should also turn it two complete revolutions, which would carry the index of the second small circle from 1 to the 3326 following 100. Then the figures of the product will be exhibited very accurately on the principal circle, and much less accurately on the first of the small circles, but they would be found in that series of numbers which follows 1000, and the place of the decimal point would thus be exactly defined.

For the multiplication of three or more numbers, it is necessary to plant moveable indices after performing the first products; this process, however, is much less convenient than that with two sliding scales in the sliding rule.

The Astronomer Royal remarked, that in his opinion this construction is too expensive and too cumbrous to be extensively used. But he wished much to call the attention of members of the Society to the use of the sliding rule, and to the peculiar defect which he had indicated; and to represent to them the great value of any simple construction which, while preserving the other advantages of the sliding rule, would effectually remove that defect.

Mr. Drach suggests that a calculating machine, exhibited by Mr. F. Schiereck in 1837 (the construction of which was concealed by the inventor, who wanted 700*l.* for his secret), might probably

be a particular modification of the sliding rule applied to a circular form. He also suggests the addition of other concentric circles to Mr. Bell's scale, in which the trigonometric or other logarithmic numbers might be laid down.

The Astronomer Royal gave an oral statement of the progress made by Lord Rosse in the mounting of his 6-feet speculum.

In a lecture delivered on this subject by the Astronomer Royal in November 1848, a detailed account was given of the distortions produced in the speculum by using the telescope at different inclinations to the horizon, and of the explanation of these distortions suggested by Lord Rosse, and also of the nature of the remedial measures tried by Lord Rosse while the Astronomer Royal was at Parsonstown. It will be sufficient to recall here, that when the edge of the speculum rested against short iron pillars fixed in the breech-piece of the telescope, the firm hold produced by friction of the edge of the speculum on the pillars, combined with the varying elasticity of the triangular lever-supports in different inclinations of the telescope, produced distortion of the mirror; and that when, to avoid this friction, the mirror was suspended (as regarded its edge-bearing), either by a semicircular hoop or by a chain, a small difference in the edgewise pressure, depending on a difference of inclination of the telescope, threw some of the points of the supporting levers out of bearing, and distortion of the mirror was produced. This latter fault arose from the circumstance that the mirror could not slip freely over the points of the supporting levers. To remedy this, the following arrangement is now made. Each of the plates resting on the 27 supporting points, instead of being partially attached to the mirror by a layer of felt and pitch, is completely separated from it, to the distance of about  $1\frac{1}{4}$  inch, and the speculum rests upon each plate by 3 turned brass balls at the three angles of the plate; so that the whole surface of the speculum is now supported by 81 brass balls. Each of these balls has a fine wire, passing through a small hole in the plate, and kept in tension by a weak spring on the opposite side; this prevents the ball from rolling away when the mirror is detached, but allows entire freedom of motion to the ball, to the extent of about 1 inch in any direction. Lord Rosse has reason to think that this construction is perfectly successful for its object. He has already found that the speculum may be moved laterally half an inch without the smallest discoverable distortion. Before the balls were used, when the speculum was moved laterally  $\frac{1}{30}$  of an inch, vision was destroyed.

Lord Rosse thinks it, however, desirable to arrange the edgewise support, so that as little as possible may be trusted to the motion of the balls. The lower semicircle of the edge is now to be grasped by a strong iron hoop, very neatly fitted to it; and the upper semicircle is to have a thin hoop furnished with a drawing-screw or contracting screw, merely for the purpose of bringing the strong hoop constantly into fair contact with the edge of the mirror. And the ends of the strong hoop (which are at the extremity of a hori-

zontal diameter of the mirror) are to be supported by rods, attached to a horizontal bar which rests on the two upper pillars of the breech-piece, with the utmost freedom of motion; so that the mirror will be supported edgewise by jimbals of the most perfect construction. Lord Rosse hopes that, with this arrangement, in combination with the support on the balls already described, the mounting of the mirror will be sensibly perfect.

Lord Rosse had also communicated to the Astronomer Royal some remarks upon the process of grinding large mirrors. With mirrors of 3 feet aperture there is not the smallest difficulty. In the mirrors ground and polished by his apparatus, there is no appreciable difference of focal length of the central part and the annulus next the edge; and this result is obtained uniformly. Still, with the 6-feet mirrors there is great difficulty. In all cases, a figure is obtained which will do well for work; rarely is one obtained which is perfectly satisfactory. This arises in part from the impossibility of testing the mirror while it is under the machine.

Adverting to Mr. Lassell's use of a wooden polisher, Lord Rosse had stated to the Astronomer Royal, that he himself had at first used a wooden polisher, but that he had abandoned it, as there appeared to be abundant evidence that the polisher was continually changing its figure from the absorption of moisture. He considers it totally inadmissible for very large specula. It will, however, probably be necessary, with Mr. Lassell's apparatus, to use a light wooden polisher, because it appears scarcely practicable in that apparatus to apply a counterpoise.

In speaking of the results of observations with the large telescope, Lord Rosse had stated to the Astronomer Royal that the nebula H. 131 exhibited a well-marked spiral structure, and that 2241 has a central hollow.

In the *Monthly Notices*, vol. ix. p. 214, line 34, Mr. Hartnup has thrown out a suggestion that the indifferent rate of chronometers, W. Shepherd, 222 & 230 (fitted with Mr. Hartnup's new balance), might be due to mal-position during trial (the maker had left pins at the bottom projecting below the base rim).

Since the publication of that number, the Editor of the *Monthly Notices* has, by the favour of the Astronomer Royal, been permitted to inspect the arrangements of the chronometer-room at Greenwich, and to see the various contrivances adopted there to give every chronometer a proper *assiette*, whatever the form of the base may be. The Editor is now convinced that Mr. Hartnup's hypothesis is not tenable, and he takes some blame to himself for not inquiring into the matter before publication.\*

The heliameter by the Brothers Repsold, of Hamburg, has been erected at the Radcliffe Observatory, and is now undergoing

\* Chronometer-makers, who send their timekeepers to Greenwich for trial, should give them as wide a base as the case will allow, and take previous care to make them rest soundly on the base rim when placed on a flat surface. This would save trouble, and prevent possible misapprehension.

about  $1^{\circ}\frac{1}{2}$  further on. Thus it had moved in the same track, though invisible. On its reappearance it was neither so large nor so brilliant as before, and gave the impression of a body moving rapidly and nearly directly *from* the observer. It was orange-red, and was visible about  $5^{\circ}$  besides the time of disappearance. The length of its path after its reappearance was about  $3^{\circ}$ . The disappearance might be accounted for by supposing the meteor to shine by borrowed light, and to have passed through the umbra of some solid body. Sir John Lubbock suggests that it may have passed through the shadow of the earth.

At Castle Lecky, Newtown-Linawady, County of Londonderry, Mr. Webb saw (Nov. 1<sup>d</sup>, at 11<sup>h</sup> P.M.) in the north, a descending meteor, which having fallen a considerable distance in an inclined straight line, diverged suddenly (to the west) on approaching towards a dense cloud. The meteor described a curved path, concave to the cloud, by which it was evidently diverted, and then disappeared.

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#### ERRATUM.

Vol. IX. p. 221, *Ceres*, July 13, Comp<sup>d</sup>—Obs<sup>d</sup> R.A., for + 12<sup>h</sup>.64 read + 11<sup>h</sup>.64.

# ROYAL ASTRONOMICAL SOCIETY.

VOL. X.

December 14, 1849.

No. 2.

G. B. AIRY, Esq., President, in the Chair.

John T. Barber, Esq., B.A., Ettwell, near Uttoxeter, Staffordshire ;

Rev. Robert Smith Bower, Rector of St. Mary Magdalen with St. Gregory by St. Paul's ;

J. W. Long, Esq., Manchester ;

Thomas Hopkirk, Esq., Eltham, Kent ;

Robert Worthington, Esq., Crumpsall Hall, Manchester ; and

John Hipplesley, Esq., Ston Easton, near Bath, Somerset ;

were balloted for and duly elected Fellows of the Society.

The illumination of the Oxford Heliometer is *not* by powerful magnets, as mentioned in the last Number. This mode of illumination was proposed and executed by Messrs. Repsold, but not found to be altogether satisfactory by Mr. Johnson. An alteration, therefore, has been made in this respect. Two large cells of a battery of Grove's construction give a light more than sufficient for the illumination desired.

Some extra copies of Mr. Lassell's "Description of a Machine for polishing Specula, with Plates," have been struck off, to satisfy the extra demand which was felt for that memoir. These may be purchased at the apartments of the Royal Astronomical Society, price 1s. to Fellows, and 2s. to the public.

## METIS.

LIVERPOOL.

Equatoreal.

(Mr. Hartnup.)

	Green. M.T.			R.A.			N.P.D.			Comput <sup>d</sup> .—Obs <sup>d</sup> . Stars of Comp.		
	h	m	s	h	m	s	°	'	"	R.A.	N.P.D.	B.A.C.
1849.												
Nov. 26	7	22	8.2	22	18	0.66	106	42	38.2	-0.66	-5.1	7980
Dec. 6	6	57	15.8	29	56	.69	105	8	52.4	0.70	5.6	...
19	5	42	29.5	47	19	.65	102	55	27.2	0.58	3.2	7976
20	5	4	1.2	48	42	.47		44	56.6	0.50	3.6	7952, 8109
23	5	9	29.5	22	53	1.86	102	12	5.5	0.63	4.3	7974, 8109
28	5	59	6.9	23	0	27.41	101	15	42.3	-0.53	-3.6	...

"The observations are corrected for refraction and parallax. The computed places were deduced from Mr. Graham's ephemeris. The stars of comparison are taken from the catalogue cited."

## NEPTUNE.

LIVERPOOL.

Equatoreal.

(Mr. Hartnup.)

		Green. M.T.		R.A.		N.P.D.		Computed.—Observed.	
		h m s		h m s		° ' "		R.A. N.P.D.	
1849.									
Oct. 28		8	40 23	22	17 25.68	101	24 52.72	+0.09	—0.05
Nov. 3		7	53 6		15.95	25	42.38	0.10	+0.27
	12	7	13 17		9.83	26	9.53	0.04	—0.10
	13	8	25 50		9.64	26	7.53	0.19	+1.16
	15	5	56 59		10.07	26	5.19	0.05	+0.10
	16	7	28 50		10.31	26	1.73	+0.17	+0.43
	24	5	56 18		17.97	25	12.93	—0.04	—0.54
	26	5	28 14		21.05	24	53.51	+0.02	0.84
	27	5	16 40		22.80	24	42.56	0.05	0.85
	28	6	7 18		24.77	24	31.36	0.06	1.87
	30	7	35 46	22	17 29.04	101	24 4.30	+0.16	—1.44

"The observations are corrected for refraction and parallax. The star of comparison for all the observations is  $\sigma$  Aquarii. The mean R.A.  $22^h 22^m 39^s.01$ , and N.P.D.  $101^\circ 26' 56''.0$ , for Jan. 1, 1849, has been taken from the Greenwich catalogue of 1439 stars for 1840.

"The computed places were deduced from Mr. Sears C. Walker's ephemeris, published in the *Smithsonian Contributions to Knowledge*. Appendix I. to Vol. II."

The Astronomer Royal resigned the chair to the Rev. R. Sheepshanks, and gave an oral statement, illustrated by models and diagrams, "On the Method of observing and recording Transits, lately introduced in America; and on some other connected subjects."

The Americans of the United States, although late in the field of astronomical enterprise, have now taken up that science with their characteristic energy, and have already shewn their ability to instruct their former masters. The method of observing which it is the object of this lecture to explain, was apparently suggested at first by the obvious practicability of applying the Galvanic Telegraph (so extensively used in America) to the determination of differences of terrestrial longitude; and it was first used for the differences of longitudes of the cities Louisville, Cincinnati, and Pittsburg. It appears that this first application of the principle is entirely due to Dr. Locke of Cincinnati. It became, however, evident that the same method might be used conveniently for recording the observations made at one or at several instruments in the same observatory; and Professor Mitchell, also of Cincinnati, actually prepared an apparatus at the Observatory at Cincinnati, and with it made observations, specimens of which have been sent to individuals in this country. One of these specimens was exhibited by the Astronomer Royal to the meeting. Between the systems of Dr. Locke and Professor Mitchell there is one radical difference, namely, in the principles of giving the signal of observation; in the principles of recording the signal there is also a difference, but this

difference is not essential, and there appears to be no reason why the same method of making the record should not be used in both systems. It will perhaps be most convenient to begin by describing the methods of making the record, which are, or may be, common to both systems.

The general principle of the methods, as regards the act of the observer, and its difference from the act in the ordinary observation of transits, is the following :—In ordinary observations the observer listens to the beat of a clock while he views the heavenly bodies passing across the wires; and he combines the two senses of hearing and sight (usually by noticing the place of the body at each beat of the clock) in such a manner as to be enabled to compute mentally the fraction of the second when the object passes each wire, and he then writes down the time in an observing-book. In these new methods the observer has no clock near him, or at least none to which he listens; he observes with his eye the appulse of the object to the wire, and at that instant he touches an index, or key, with his finger; and this touch makes, by means of a galvanic current, an impression upon some recording apparatus (perhaps at a great distance), by which the fact and the time of the observation are registered. He writes nothing, except perhaps the name of the object observed.

The method adopted by Dr. Locke was that of interrupted indented lines, produced by the pressure of a point or style (effected by a galvanic magnet whose current is interrupted occasionally) upon a fillet of paper, which is drawn by machinery with a nearly uniform speed under the style. With this apparatus it is evident that a signal almost instantaneous in duration can be given; either by supposing the ordinary state of the apparatus to be that of exerting a pressure on the style, and giving the signal by interrupting the galvanic current; or by supposing that in the ordinary state of the apparatus no pressure is exerted, and that the signal is given by completing the galvanic circuit, which animates the magnet and creates an instantaneous pressure. In the first of these forms the record will exhibit the appearance of long lines interrupted by very short intervals; in the second it will have the appearance of punctured dots, with wide spaces between them. Now, as no reliance whatever can be placed on the uniformity of speed of the machinery which draws the fillet, it is necessary to make such connexion of the apparatus with a trustworthy clock, that the seconds (or other uniform intervals) of the clock shall be recorded in the same manner upon the same fillet. If this be effected by the same galvanic communication and the same magnet, then, in the first case (or that in which the ordinary state is that of pressure on the style), the record will consist of an indented line, interrupted at short and sensibly equal intervals corresponding to the seconds marked by the clock, and interrupted also at other points corresponding to those instants at which the observer has, by a voluntary effort, interrupted the galvanic circuit in order to give a signal. This is the method adopted by Dr. Locke. In the second

case (where in the ordinary state no pressure is exerted), there will be a series of punctured dots at sensibly equal intervals corresponding to the seconds of the clock, and, mingled with these, there will be the dots corresponding to the instants at which the observer has completed the galvanic circuit. This is the method adopted by Professor Mitchell.

In either of these methods there is no difficulty in producing such a variation, repetition, or omission, of the clock-signals, as will distinctly mark the beginnings of minutes, of every five minutes, &c.

Dr. Locke appears to have been induced to adopt the method of registering by interrupting the circuit (which in its ordinary state was complete), by the following consideration:—His object was to record upon one moving fillet of paper at Cincinnati the observations made at three stations (Louisville, Cincinnati, and Pittsburg,) and also the seconds of the clock. He remarked, then, that the interruption of the circuit for any one place would interrupt it for all; and therefore, at whatever place the signal of observation was made by interruption of circuit, the corresponding interruption would necessarily be made in the indented line on the fillet of paper. But he remarked also that the connexion of the parts of the circuit at one place would not effect the connexion for all; and he appears to have inferred that, if a single wire only were used extending along all the stations, it would be impossible to use it by the method of completing the circuit for signal, and that, in fact, a separate wire would be necessary for each separate station. This inference, as the Astronomer Royal shewed by diagrams, is incorrect. If the battery and the recording apparatus are near together, then it is only necessary to have a single trunk-wire passing by all the stations (including the clock as one); and to have a branch-wire passing through the recording apparatus to the battery, and a communication from the other end of the battery to the ground; and also to have a branch-wire through each station to the ground, interrupted in its ordinary state, but admitting of connexion at the will of the observer, or by the motion of the clock. Then, at whatever place the observer completes the connexion with the ground, the galvanic circuit through the recording apparatus is completed. Or, in the most unfavourable case (which is never likely to occur), of the battery at one extreme station, and the recording apparatus at the other extreme station, it is only necessary to have one trunk-wire proceeding from the battery through all the stations, and another trunk-wire parallel to the first proceeding from the recording apparatus through all the stations; then, at whatever station the connexion between these two trunk-wires (properly furnished with small branch-wires) is made by the observer, the circuit through the recording apparatus is completed.

The method of recording by the use of a fillet of paper, strictly speaking, is used only by Dr. Locke. The equivalent method used by Professor Mitchell is, to cause a circular disk to revolve with a smooth and nearly uniform motion (by means of a Fraunhofer's

regulator), upon which disk the impressions of the style form a dotted circle; then, at the end of each revolution, a tooth upon the axis of the disk takes hold of a fixed rack and moves the travelling frame, which carries the centre of the disk, through a small space, so that the traces of the succeeding circle are prevented from mixing with those of the preceding circle. Professor Mitchell alludes to the practicability of using a cylinder which turns upon a screw axis, so that the traces will be made in a perpetual spiral; and there can be little doubt that this construction would be preferable to that of the circular disk. Among other reasons, the habitual estimation, or the measure, of the fractions of the seconds, would probably be more accurate where the length corresponding to a second is uniform, than where it varies from one circle to another, as it does on the circular disk.

The momentary interruption of the circuit in Dr. Locke's method, or the momentary completion in Professor Mitchell's method, for the register of observations, is made by touching a key nearly similar to that of a musical instrument. This key may be attached to the observing chair or to the astronomical instrument. Dr. Locke has not, however, fully described the mechanism by which he makes his clock interrupt the circuit. Professor Mitchell describes the action of his clock in the following manner:—A delicate fibre attached to the pendulum of the clock acts upon a "cruciform" lever [probably a rectangular or "bell-crank" lever], and thus, in every double swing of the pendulum, allows a metallic point to dip into a cup of quicksilver, and to complete the galvanic circuit. Thus, in Professor Mitchell's register the clock-dots are made at every two seconds. Professor Mitchell has found it convenient to use, for the seconds-record, a pen or style different from that which is used for the observation-record. He does not mention whether he uses for the seconds-record a battery different from that used for the observation-record; but this appears necessary to prevent the confusion which might arise in the register on making observations exactly at the second of time; for the completion of the battery-circuit by one wire would probably interfere with the efficiency of the circuit through the other wire.

The Astronomer Royal does not hesitate to express his preference of Professor Mitchell's form of register to Dr. Locke's.

The practicability of this method of recording observations being fully established, it then becomes an important question for the observing astronomer, whether this method is or is not more accurate than the usual method of observing by the combination of eye and ear. The question is, really, whether the connexion between the nerves of the eye and of the finger is or is not closer than that between the nerves of the eye and of the ear: it is purely a physiological question, which can be settled only by experience. Professor Mitchell has investigated it in the following manner. Extracting from the printed Greenwich Observations a number of transits of *α Coronæ*, and comparing their intervals with the intervals as established from observations of the pole-star, he has

obtained a measure of what may be called Greenwich Irregularities. Using the same process for the observations recorded by the Galvanic Register, he has obtained a measure of Cincinnati Irregularities. The magnitude of the latter is only about one-fourth of that of the former. The Astronomer Royal suggested that a portion of this difference might be owing to the difference in the state of the two atmospheres, the atmosphere of England being perhaps comparatively unfavourable to accurate observation. The result of Professor Mitchell's comparison is, however, very encouraging as regards the probable success of the method.

One important advantage of this method would be the contraction of the time of observing a transit. Instead of using wires 12" or 15" apart, intervals of 2" will be amply sufficient. Advantage may be taken of this, either for the observation of numerous objects, or for observation over numerous wires. One inconvenience of the method, however, is, the trouble of translating the graphical registers into numbers. Another inconvenience, of great weight, is the extent of recording surface that will be required, unless the recording machinery be very frequently disengaged, and its records (to a certain degree, not essentially injurious, but troublesome) be rendered discontinuous. In the Royal Observatory of Greenwich it is by no means uncommon to have trains of interrupted observations extending over twelve hours, or even a longer time, at once. An unbroken series of time-marks of 12 hours in Dr. Locke's method, allowing 1 inch to each second, would require 3600 feet of paper fillet; in Professor Mitchell's method, allowing  $\frac{1}{3}$  inch for each second, and  $\frac{1}{10}$  inch between successive lines of dots, it would require a sheet of 1440 square inches of paper.

The Astronomer Royal then stated that the possible advantages of this method appeared so great that he had begun to contemplate the practicability of adopting it in the Royal Observatory. One reason exists there which probably exists nowhere else, namely, the regularity of use of the Altitude and Azimuth Instrument by the method of transits, and the necessity of referring these transits (with the smallest possible uncertainty on personal equation) to the same clock to which the meridional transits are referred. In adopting Professor Mitchell's general method, he would propose to record the observations upon a cylinder, perhaps revolving upon a screw-axis. It is proper to remark, that this screw-axis may be so mounted upon friction-wheels that the friction would be quite imperceptible. The friction-wheels must not have their planes transverse to the axis, but in such a position that their edges follow the threads of the screw; and, supposing that there are two friction-wheels at each end, one of the four must be fixed in place, and the others must be mounted on frames which have a small hinge-motion in the direction perpendicular to the planes of the wheels. Or, instead of using the screw-motion, the frame which supports the axis of the cylinder may run upon a railway, along which it will be carried by rack-and-pinion mechanism, receiving its movement from the clock-work. The motion of the cylinder may be given by a toothed wheel

on one end, which works in a stiff pinion, long enough to admit the toothed wheel to slide along it through a space equal to the length of the cylinder.

In using this cylindrical record, it is obvious that great convenience would be gained if the movement of the cylinder could be made so perfectly uniform that it could be adopted as the transit-clock. Then the second-registers could be made on it by the same clock which moves it (either by galvanic contact or mechanically), and their places would bear a constant relation to the lines parallel to the axis of the cylinder. The Astronomer Royal, therefore, urged strongly the importance of improvements of the centrifugal or conical-pendulum clock, as the only instrument yet made which is able to do heavy work with smooth motion, and with an accuracy at present so great as to make it probable that, with due modification, the greatest accuracy may be obtained. Setting aside the consideration of Fraunhofer's clock, as an instrument which, for purposes like these, is rude, the Astronomer Royal stated that, as he believed, the first efficient conical-pendulum clock was that made by Mr. Sheepshanks, in which the expansion of the balls to a certain angle produces suddenly a friction which, as soon as it amounts to an equivalent to the maintaining power, prevents further acceleration. Theoretically, the speed of this clock depends in a very small degree on the maintaining power. In order to remedy this small defect, the Astronomer Royal had introduced the use of water-power (by the modern form of Barker's mill or reaction engine) as the moving force, and had regulated the supply of water by Sieman's chronometric governor. The principle of this governor may be used in various forms; the following, perhaps, will serve to explain it most clearly. Suppose the last wheel of the moving-train to be a bevelled wheel whose plane is horizontal, carried by a vertical spindle; and suppose the spindle of the centrifugal balls to be above the moving-train spindle, in the same vertical line, but separate, and carrying a bevelled wheel similar to the other, but in the opposite position; and suppose the connexion between these two bevelled wheels to be made by an intermediate bevelled wheel, whose plane is vertical, and whose axis passes between the two; the train-spindle and the balls-spindle will evidently rotate in opposite directions. The axis of the intermediate wheel must not be fixed, but must be capable of turning in a horizontal plane, and it must be pulled by a weight (acting by a line over a pulley, or a right-angled lever), in the direction of turning the ball-spindle; it must also be connected with the water-valve in such a way that the same pull will tend to open the water-valve. It is evident now that, while the axis of the intermediate wheel is free to move, the force driving the bevelled wheel of the ball-spindle is rigorously uniform, and is equal to half the weight which pulls the axis of the intermediate wheel. If the moving power is suddenly increased, the immediate effect of this increase is, not to accelerate the ball-spindle, but to drive the intermediate wheel in such a manner that its axis lifts the pulling-weight, and partially closes the water-valve.

An opposite motion takes place if the moving power is suddenly diminished. In this manner the water valve is maintained in that state which supplies the force that exactly produces a determinate moving power upon the ball-spindle.

In some localities it may be difficult to obtain the proper supply of water, and in some there may be danger of obstruction by frost. The Astronomer Royal had, therefore, endeavoured to effect the same object by the use of weights. By a remontoir-train the uniformity of rotation of the balls might undoubtedly be secured; but then the motion of the primary wheels of the train would be intermittent. The following plan, however, appears to the Astronomer Royal to be perfect. Let the arrangement of the three bevelled wheels and the pulling weight be exactly the same as that above described, but let the train-spindle carry a broad flat disk, whose plane is horizontal; upon this let a lever press by a definite projection from its lower side, and on the upper side of the lever let there be a sliding weight (as a ball running in a groove); let the spindle of the intermediate bevelled wheel command the place of this ball by a fork projecting downwards, loosely including it; and let the tendency of the pulling weight be to draw this ball towards or over the fulcrum of the lever, so as to diminish the pressure of its definite projection upon the flat disk. Then, if the moving force is suddenly increased, its immediate effect will be to drive the intermediate wheel in such a direction as to push the running ball further along the lever, and thus to increase the pressure of its projection upon the flat revolving disk, and to produce a friction which will absorb the excess of power.

There are still two practical defects which it is desirable to remove.

The first is, the amount of friction in the rotation of the balls; which, indeed, is so great, that in the clock-work used for equatorial motion it consumes by far the greater part of the power. In the shape in which Sieman's regulator is usually applied to steam-engines, with one ball revolving by a rod whose support is a ball-and-socket joint, the friction is intolerably great. When balls are mounted on a vertical spindle, the friction, although much diminished, is still far too great. The Astronomer Royal had therefore directed his thoughts to the mounting of the conical pendulum, so as greatly to diminish the friction. In the summer of 1846 he chanced to see at the *Gewerbe Ausstellung* of Wiesbaden\* a beautiful centrifugal-ball clock, intended for a drawing-room. The maker had acutely remarked that the circular motion might be resolved into two rectangular motions, and that each of these might be produced by the vibratory motion of a knife-edge. The pendulum,

\* The mechanical talent of inland Germany, having had little employment in the construction of powerful engines or manufacturing machinery, appears to have developed itself in the invention of clock-work. The Museum in the Schloss of Gotha contains a remarkable collection of clocks embodying every conceivable device. None, however, has appeared to the Astronomer Royal so remarkable for the accuracy of its mechanical conception as that which is described in the text.

therefore, vibrated immediately by a knife-edge upon concave agates carried by a small frame, and this frame itself was furnished with knife-edges in the direction transversal to the former, which vibrated upon concave agates carried by the fixed frame of the clock. The pendulum thus moved with so much freedom that it was kept in conical vibration by a small maintaining power, acting ultimately by a light radial arm to maintain the rotation. The arc of expansion was determined (as in ordinary pendulums) merely by the resistance of the air.

This motion on knife-edges is liable to the same objections as the use of knife-edges for clock-pendulums. The Astronomer Royal therefore proposes to substitute for them a mounting by springs. The pendulum is immediately supported by two springs from a frame, and this frame is itself supported from the fixed parts of the clock-frame by two springs whose relative position is transversal to that of the former, and whose plane of vibration is transversal to that of the former; the form of the intermediate frame being such that, when the pendulum hangs in a vertical position, the upper ends of the four springs will be in one horizontal plane, and the lower ends will also be in one horizontal plane. A model of this mounting was exhibited. The motion is most satisfactory; the pendulum revolves many times before the diameter of its circle is diminished to one-half. In the complete clock-work the power of the train is to act on this by a radial arm.

The second defect, which will only be sensible when the mechanism has received these improvements (but of the distinct effect of which the Astronomer Royal has no doubt), is the want of compensation for the thermal expansion of the pendulum rod. Supposing the limiting arc of vibration determined by rotation within a ring, the contact of the rod with which produces the friction that prevents further acceleration, the Astronomer Royal proposes the following simple construction. The ring is to be of brass, and is to be carried in two or more points of its circumference by horizontal bars, each bar being supported at the extremity furthest from the ring by an iron pillar, and at some point between the iron pillar and the ring by a brass pillar; the pendulum rod and all other parts of the frame being of iron. The expansion of the brass ring, and its elevation by the effect of the different expansion of the two pillars carrying each horizontal bar, will both contribute (and may be made to do so to any assignable degree) to permit the greater angular expansion of the conical motion which is necessary for isochronism when the pendulum rod is lengthened by heat. [It is well known that the time of rotation of the conical pendulum depends only on the vertical depression of the ball below the horizontal plane passing through the centre of motion.]

It may, however, be thought preferable to employ a mercurial pendulum of the ordinary construction as regards compensation, revolving in a very small circle, whose diameter is perhaps equal to the usual arc of vibration of a common clock pendulum, and whose dimensions are limited only by the resistance of the air. The radial

arm ought to act on a slender spike at the bottom of the masonry-cistern. The pulling-weight would be very light, but the efficiency of the regulation would not be diminished by that circumstance. No ring would be necessary, except as a safety-guard, to prevent the machinery from running wild on any accidental excursion of the pendulum beyond the end of the radial arm.

The Astronomer Royal then remarked that, considering the problem of smooth and accurate motion as being now much nearer to its solution than it had formerly been, it might be a question whether, supposing a sidereal clock made on these principles to be mounted at the Royal Observatory, it should be used in communicating motion to a solar clock. It might by some persons be thought advantageous, even now, that the drop of the signal-ball (at 1<sup>h</sup> Greenwich mean solar time) should be effected by clock machinery; and it is quite within possibility that a time-signal may be sent from the Royal Observatory to different parts of the kingdom at certain mean solar hours every day, by a galvanic current regulated by clock machinery. Whether it would be advisable that this should be done by machinery proceeding originally from the sidereal mover, would be a question for consideration at the proper time; but, at all events, the Astronomer Royal desired to shew that the problem is practically possible to an astonishing degree of accuracy. Dr. Henderson, of Newferry near Birkenhead, had communicated to the Astronomer Royal, and had permitted him to make known to the Society, the following numbers for the teeth of wheels. If there be three spindles, Nos. 1, 2, and 3, No. 1 revolving in a mean solar day of 24 hours, or 86,400 solar seconds, and if No. 1 carries a wheel of 247 teeth working in a wheel of 331 teeth on No. 2, and if No. 2 also carries a wheel of 43 teeth working in a wheel of 32 teeth on No. 3, then No. 3 will revolve in  $23^h 56^m 4^s.09001$ . Again, if there be four spindles, Nos. 1, 2, 3, and 4, No. 1 revolving in a mean solar day of 24 hours, and if No. 1 carries a wheel of 96 teeth working in a wheel of 79 teeth on No. 2, and if No. 2 also carries a wheel of 157 teeth working in a wheel of 133 teeth on No. 3, and if No. 3 also carries a wheel of 72 teeth working in a wheel of 103 teeth on No. 4, then No. 4 will revolve in  $23^h 56^m 4^s.09235$ . The length of the sidereal day adopted in the *Nautical Almanac* is  $23^h 56^m 4^s.0906$ . The approximations to it obtained above are very remarkable. By reversing the same train of wheels, accurate motion corresponding to sidereal time will be made to generate motion corresponding with the same degree of approximation to mean solar time.

*Results of the Observations made by the Rev. Fearon Fallows at the Royal Observatory, Cape of Good Hope, in the years 1829, 1830, 1831. Reduced under the superintendence of G. B. Airy, Esq., Astronomer Royal.*

The Astronomer Royal commences his memoir with a historical introduction, in which the origin and progress of the principal British Southern Observatory are fully developed. The official papers preserved at the Admiralty have been carefully examined, by permission of their Lordships, and the minutes of the Board of Longitude are kept at the Royal Observatory for safe custody.

On the 3d February, 1820, and at a full meeting of the Board of Longitude, Mr. Davies Gilbert proposed, and Sir Joseph Banks seconded the proposal, that the Board should take into consideration "the propriety of establishing an Observatory at the Cape of Good Hope." This was acceded to, due inquiries were made, the proper official steps taken, and, finally, the Observatory was founded by an Order in Council, dated 1820, October 20.

The instruments were ordered from the following artists:—A 25-foot zenith sector, by Mr. Troughton (which was never begun); a 10-foot transit, by Mr. Dollond; and a 6-foot mural circle, by Mr. T. Jones. The personal establishment consisted of

One Astronomer at 600*l.* per annum.

One Assistant, 250*l.* ditto.

One Labourer, 100*l.* ditto.

And on October 26, 1820, the Rev. Fearon Fallows, M.A., Fellow of St. John's College, Cambridge, was appointed as astronomer. A sketch of a plan for the Observatory was prepared by Mr. Rennie, with the aid of Mr. Fallows, after consulting Messrs. Pond, Troughton, &c., which was approved of on February 1, 1821, when "a plan in detail" was ordered. On the 4th of May, 1821, Mr. Fallows set sail for the Cape, and arrived there on August the 12th.\*

After a very extensive and careful survey of Cape Town and its neighbourhood, Mr. Fallows selected the site on which the Observatory now stands. He had abundant difficulties and annoyances to complain of, and there seems to have been some unnecessary delay in sending over the plans for the building. Unfortunately the portable instruments taken out by him were of very moderate pretensions, and thus the labour of some years was rendered comparatively useless. The large instruments did not arrive till December 1826, and the Observatory was not in a state to receive them till 1828. In 1829 the astronomical work commenced in earnest. The transit instrument was soon found to deserve perfect confidence, but the mural circle gave infinite trouble and vexation. Indeed a mystery hung over this instrument until after its return to England, when it was thoroughly examined by Mr. Simms, under the direction of the Astronomer Royal. After suffering for some time from bad health, Mr. Fallows died 1831, July 25.

\* There is a brief sketch of Mr. Fallows' life in the Report of the Council of the Royal Astronomical Society, *Memoirs*, vol. v. p. 404.

By the kindness of Professor Charles Piazzi Smyth (formerly assistant in the Cape Observatory) Mr. Airy has been enabled to give a ground-plan of the Observatory.

After this historical account the Astronomer briefly states the contents of the MSS. which have been submitted to him, and the processes of verification and reduction.

The transit observations extend from April 11, 1829, to March 30, 1831. There are three copies, but apparently not one, strictly speaking, an original. Mr. Airy has adopted as his authority that called by Mr. Fallows the "third or clean copy."

The transit instrument is that still in use at the Cape Observatory, which is described by Mr. Maclear in the *Cape Observations* for 1834. Its focal length is 10 feet, aperture of the object-glass, 4.9 inches, with seven wires. Mr. Fallows observed only on the five middle wires (except by mistake), and his books are ruled for only five wires. This excellent instrument is the work of Mr. Dollond.

The distances of the wires have been carefully examined, and, in a few instances, the observations corrected by an alteration of one or more seconds. A few observations have been rejected.

Mr. Fallows has always given the mean of the five wires, when fully observed, in a separate column; in order to obtain the necessary data for the imperfect transits, 87 transits of  $\beta$  *Hydri* have been employed to compute the intervals of each of the five wires. For the extreme wires Mr. Airy has adopted the intervals determined by Mr. Maclear (see *Cape Observations*, 1834), the wires being the same for both observers.

The error of collimation, which is first to be determined, appears from Mr. Fallows' notes to have been as nearly as possible annihilated by adjustment, when necessary; this, however, was exceedingly seldom. It is evident, from the data adduced, that the instrument was very firm, and that no perceptible error is introduced by assuming, with Mr. Fallows, that the error of collimation and error in the form of the pivots may be neglected.

The level was frequently applied, and the level error deduced by Mr. Fallows was applied by him to the observations in the course of reduction up to March 31, 1830. These level corrections have been tested, and the mistakes rectified. After the date mentioned, the level errors are so small as to be insensible, and have been neglected.

Mr. Fallows appears to have determined his meridian mark very carefully by repeated observations of  $\beta$  *Hydri*, and to have relied upon the mark *only* for observations after March 1830. The corrections for azimuthal deviation have been applied by him to the earlier observations, and these have been examined and corrected, when necessary, by the observations of  $\beta$  *Hydri*. There are not sufficient astronomical data for determining the deviation after the date mentioned, and it has been assumed that there was no sensible error, as was evidently supposed by Mr. Fallows.

After applying these corrections, the time by the clock of the transits over the meridian was obtained.

The next step was to deduce the clock error. Mr. Fallows had followed the plan employed by Maskelyne, viz. to assume approximate right ascensions of certain bright stars (*α Orionis*, *Procyon*, *α Aquilæ*, and occasionally *Spica*), with one of which each star was compared, reserving the determination of the correct right ascension of the fundamental star until he should have reduced his observations of the equinoxes. This method was perhaps justifiable at that time, when there was no very exact recent catalogue of authority in existence. The case is now altered, and Mr. Airy has determined the clock errors, rates, &c. almost exactly as in the Greenwich Planetary Reductions, using Bessel's Catalogue for 1830, contained in the *Tabulæ Regiomontanæ*. Where these were insufficient, other stars were taken from Pond or from Piazzi, which were brought up by the corresponding precession, and by proper motion deduced from a comparison with Bradley.

The clock errors being thus found, were divided into 352 groups, each group being usually the result of a day's observation, and from these a rate was concluded for each group. Finally, a fictitious clock error for 0<sup>h</sup> was found, as in the Greenwich practice. The clock appears to have gone well.

The clock error at 0<sup>h</sup>, and the proportional part of the clock rate, were then applied to every clock time of transit over the meridian, and thus an apparent right ascension, as given by observation, was found. But no result was retained for a clock star, unless there were at least three clock stars in the group.

Mr. Fallows had completed the reduction of the apparent to mean places for nearly all the stars as far as March 31, 1830. The results only, however, are given, and hence it became necessary to check and verify them, which was accordingly done. For the stars not reduced by Mr. Fallows, corrections were computed for every separate determination by the constants of Bessel, &c.

The mean places of the stars from observation having been thus found for the beginning of the year of observation, those which were observed in 1829 or 1831 were reduced to 1830 by the application of a year's precession, and thus the ledger of results in right ascension for every separate observation of the stars was completed.

Having thus explained the reduction of the Transit Observations, which form the principal part of Mr. Fallows' MSS., Mr. Airy proceeds to a description of the process followed in reducing the Circle Observations. Of these there is one copy, commencing April 2, 1830, and terminating March 30, 1831, but though the book is entitled *Extracts from the Mural-Circle-Book of the Royal Observatory, Cape of Good Hope*, it probably contains all the observations made.

In a note, Mr. Fallows gives a short history of the circle from its arrival at the Cape to its final erection. He mentions that Captain Ronald had reported to him a slight fall of the package while raising from the hold, but he warrants the instrument having been free from any injury after that time.

The strange anomalies in the divisions of this circle have been alluded to and examined by several persons.\* In 1840 it was sent to Greenwich, and after some examination of its large pivot, which was evidently deformed, Mr. Simms, under the directions of the Astronomer Royal, proceeded to re-turn it, when, to the great astonishment of both, the steel collar of the pivot was found quite loose, having been attached merely by soft solder. A new collar was mounted in the usual way, by *heating on*, which was carefully turned, and the instrument adapted to use. The reader will see from the details of the Observations (See *Greenwich Observations* for 1848) how large the errors of division are, when freed from sensible error in the form of the pivot.

Mr. Airy adds that "there is not the smallest appearance of mechanical injury to the instrument," and conceives that probably the first cause of the discreditable state of the divisions is the form of the pivot, by which, in Troughton's mode of division, unless checked by opposite readings, every division must have been affected. It is satisfactory to learn that Mr. Airy's use of the instrument has satisfied him of the correctness of the opinions of Messrs. Fallows, Henderson, and Maclear, viz. that the *mean* of the *six* microscopes may be fully relied on.

The first examination of the observations was for the purpose of detecting such erroneous readings of microscopes as do not exceed a few seconds, and also errors of 1', which, in this instrument, may easily occur. Several errors in the readings of microscopes and in means, which had escaped Mr. Fallows, were thus detected. Mr. Fallows' practice was to observe stars on successive days, alternately by direct and by reflected vision; a perfectly legitimate method if the instrument preserves its adjustments accurately. To obtain the zenith points, Mr. Airy applied the corrections for refraction, and also the corrections to the mean place, to the observations in the first instance. The observations were now such as would have been made if there were no refraction, and the stars were in their mean places. Then, by comparing a direct circle-reading, thus corrected, of a star one day, with a reflexion circle-reading, similarly corrected, of the same star next day, a zenith-distance point was found. These partial zenith-distance points were found to be exceedingly accordant, and so steady from day to day that the same value sufficed for a considerable group. The mean zenith distances thus found were converted into mean north polar distances, using Mr. Henderson's colatitude, which is nearly the same with that which is deduced from Mr. Fallows' observations of  $\beta$  *Hydri*.

The results thus obtained were finally combined in a catalogue, using the nomenclature of the best known catalogues as a basis. The annual variations are taken from the Catalogue of the *Royal*

\* See *Memoirs of the Royal Astronomical Society*, vol. v. for a paper by Mr. Sheepshanks, with additional remarks by Mr. Airy; vol. viii. for a notice by Mr. Henderson. Mr. Maclear made a very extensive and laborious series of measures, from which he deduced the errors of the divisions.

*Astronomical Society* when the stars occur there. For other stars the precessions are computed from the following formulæ:—

$$\begin{aligned} \text{R.A.} &= + 3''.068 + 1''.3362 \times \sin \text{R.A.} \times \cotan \text{N.P.D.} \\ \text{N.P.D.} &= - 20''.043 \times \cos \text{R.A.} \end{aligned}$$

The observations of the sun, moon, and planets, present no peculiar difficulty, as the instrumental corrections were already determined; the observations are treated nearly as such observations are treated in the Greenwich Volumes.

The North Polar Distances of the Comet of 1830\* are given as computed by Mr. Fallows with index-errors concluded from observations of  $\alpha$  *Orionis* and  $\alpha$  *Hydri*. Refraction is applied, but not parallax. Some additional observations were made of this Comet with an altitude and azimuth circle, and some measures of the distance of the cusps in the Solar Eclipse in the same year. These are not reduced, as some essential explanations are wanting.

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*A Method of Correcting the Errors due to the Forms of the Pivots of a Transit Instrument.* By Professor Challis.

The method proposed by the author requires the solution of the following problem:—Having drawn from a selected point of the middle wire of the telescope, situated near where the transits are usually taken, a straight line to the optical centre of the object-glass, it is required to find, independently of the forms of the pivots, the small angle made by this line with the plane of the meridian for any position of the telescope. The solution of this problem may be effected by employing Bohnenberger's collimating eye-piece, in conjunction with the method of measuring by micrometer-microscopes the positions of two dots at the extremities of the pivots, first suggested by the Astronomer Royal and applied by him in testing the forms of the pivots of the new altitude and azimuth instrument at the Greenwich Observatory. The collimating eye-piece gives the angle ( $\alpha$ ) which the line of collimation makes with the meridian plane when the telescope is directed to the nadir. If  $y_1, y_2$  be the vertical microscope readings for bisections of the dots in this position of the telescope,  $y'_1, y'_2$  be the vertical microscope readings, and  $x'_1, x'_2$  the horizontal microscope readings for bisections of the dots, when the telescope is pointed to an angular distance,  $z$ , from the zenith southward, and  $\xi$  be the small angle required, then

$$\xi = \alpha + \frac{y_2 + k - y_1}{D} + \frac{y'_2 + k - y'_1}{D} \cos z + \frac{x'_1 - x'_2 - h}{D} \sin z,$$

$D$  being the distance between the dots, and  $h$  and  $k$  certain constants, by means of which the readings of the two microscopes are

\* Some particulars of this Comet will be found in the *Astronomische Nachrichten*, N. 183; vol. viii. p. 300.

referred to the same vertical and horizontal planes. The constant  $k$  is found by measuring the difference of altitude of the dots in reversed positions of the instrument, the telescope being directed to the nadir, and at the same time noting by the collimating eye-piece the change of inclination of the line of collimation to the vertical caused by the reversion. The correction to be applied to an observed time of transit across the middle wire to reduce it to the time of meridian transit is  $\frac{\xi}{15} \times \text{cosec N.P.D.}$ . Hence,  $k$  may be found by two consecutive transits of *Polaris*. These constants being known, the angle  $\xi$  may be calculated for zenith distances separated by intervals of  $5^\circ$ , and extending from  $-90^\circ$  to  $+90^\circ$ . The differences between these values of  $\xi$  and the values of the same angle which would be obtained at the same time, in the usual manner, on the supposition that the pivots are perfectly cylindrical, are certain functions of  $z$ , which may be assumed to remain constant throughout the year. A table of these differences multiplied by  $\frac{\text{cosec N.P.D.}}{15}$  being formed, in which the argument is the north polar distance, any observed time of transit is first to be corrected by a quantity derived by interpolation from this table, and then the remaining reduction to meridian transit may be effected, by obtaining the collimation, level, and azimuth errors, and applying corrections on account of them, by the ordinary processes.

Capt. Charles Shea, H.C.S. has forwarded three diagrams of the configuration of *Jupiter* and the moon at his near appulse on December 7, 1849. The view was taken with a 3-foot telescope by Leary, not mounted.

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#### ERRATA.

Mr. Lowe sends the following erratum in the last *Notice* :—

Page 23, line 11, for August 19 read August 10.

Mr. Gray forwards the following errata in Shortrede's anti-logarithmic table :—

Log.	·62163	4399	4369
	·79689	for 4512	read 4552
	·92052	7683	7603

# ROYAL ASTRONOMICAL SOCIETY.

VOL. X.

January 11, 1850.

No. 3.

Rev. R. SHEEPHANKS, V. P., in the Chair.

Dr. Moffatt, Hawarden, near Chester;  
Isaac Todhunter, Esq., St. John's College, Cambridge; and  
R. L. Jones, Esq., Chester;  
were balloted for and duly elected Fellows of the Society.

Mr. R. T. Paine, of Boston, U.S., having called attention to the omission in the *Nautical Almanac* of the occultations of  $\gamma$  Virginis, for the early part of 1850,\* Lieut. Stratford has furnished the following correction:—

## Occultations Visible at Greenwich.

180.	Star's Name.	Mag.	Disappearance.		Angle from		Reappearance.		Angle from	
			Sid. T.	M. T.	N. Pt.	Vertex.	Sid. T.	M. T.	N. Pt.	Vertex.
			h m	h m	°	°	h m	h m	°	°
31	$\gamma$ Virginis	4	12 59	16 15	34	39	14 5	17 21	273	290
27	—	—	12 51	12 31	46	49	14 2	13 41	261	277

## Elements for Facilitating the Computation of Occultations of Stars by the Moon.

		Green. M.T. of App. Conj.		At Greenwich Mean Time of Conjunction.						
Star's Name.		Mag.	in R.A. of Moon and Star.			App. R.A. of Moon and Star.	App. Decl. of Star.	Diff. of App. Decl. of Moon and Star.	Limiting Parallels.	
180.			h	m	s	h	m	s		
1. 4	$\gamma$ Virginis	4	7	44	5	12 34	3' 29	S. 37 31.1	N. 49 3	89° N. 13° N.
31	—	—	16	24	17	4' 09	S. 36.2	N. 56 53	89° N. 21° N.	
1. 28	—	—	2	45	33	4' 70	S. 39.8	N. 56 23	89° N. 20° N.	
F. 27	—	—	12	46	54	4' 99	S. 41.3	N. 53 48	89° N. 17° N.	
1. 23	—	—	20	50	29	5' 03	S. 41.1	N. 56 32	89° N. 21° N.	
$\gamma$ 21	—	—	2	49	16	12. 34. 4' 89	S. 37 39.7	N. 66 40	89° N. 35° N.	

\* This oversight arose from a mistake as to the *sign* of declination. It is only wonderful that the mode of reckoning by declination instead of polar distance does not lead to more frequent and more serious errors.

Ephemerides of the newly-discovered planets for the present year are given in the *Berliner Jahrbuch* for 1852, and will not, except in special cases, be published in the *Monthly Notices*. These ephemerides will also be given in the *Nautical Almanac* for 1853, which is on the eve of publication.

## NEPTUNE.

*Unnoticed Observations of Neptune.*

Mr. Hind says,—“In looking over the zones of Dr. Lamont, observed at Munich in 1845 and 1846, I have found two observations of *Neptune* as a star, the *first* on 1845, October 25, in zone 338, when it passed the centre wire at  $21^h 42^m 43^s.1$ , and was noted as a ninth magnitude; the *second* on 1846, September 7, in zone 379, at  $21^h 54^m 24^s.9$  called an eighth magnitude. Taking the positions of a number of the brighter stars in each zone, from Airy or Henderson, I find for the apparent positions of *Neptune*:

		Green. M.T.	R.A.	N.P.D.
		<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
1845, Oct.	25	6 40 15	21 42 42.48	104 14 23.0
1846, Sept.	7	10 1 57	21 54 44.51	103 16 21.8

HAMBURG.		Equatoreal.		(M. C. Rümker.)	
1846.		Hamb. M.T.	R.A.	Decl.	
		<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	
July	25	11 57 33.6	336 23 3.3	−10 38 2.0	Equat.
	28	11 36 4.3	19 5.7	39 37.3	
	30	11 51 51.0	16 28.6	40 40.2	
	31	13 46 52.6	15 0.2	41 20.7	Mer. Circle.
Aug.	1	11 1 30.6	13 49.7	41 44.1	Equat.
	8	11 46 31.6	336 3 57.4	45 42.2	
	14	10 49 9.6	335 55 3.6	−10 49 14.5	

## Meridian Circle.

Aug.	14	12 50 29.9	335 54 54.9	−10 49 22.9
	25	12 6 7.6	38 3.0	55 54.4
	30	11 45 56.9	30 13.0	10 59 0.2
Sept.	4	25 46.9	22 35.4	11 1 59.9
	5	21 44.4	20 57.3	2 37.5
	7	13 40.7	17 58.2	3 47.8
	9	11 5 37.0	14 58.2	4 52.4
	13	10 49 29.3	8 57.6	7 10.4
	15	10 41 26.0	335 6 4.0	−11 8 19.0

1848.		Hamb. M.T.			R.A.			Dec.		
		h	m	s	°	'	"	°	'	"
Sept.	19	12	25	14.5	334	59	3.2	-11	10	57.4
	24		5	13.2		53	37.5		13	1.6
	25	10	1	13.2		52	22.3		13	28.1
	26	9	57	11.0		51	1.8		13	56.6
	27		53	10.0		49	43.9		14	26.8
Oct.	1		37	7.0		44	53.9		16	15.5
	5		21	5.1		40	17.8		18	2.0
	6	9	17	4.6		39	9.5		18	25.6
	13	8	49	4.5		32	12.0		20	59.2
	14		45	5.9		31	16.5		21	19.9
	15		41	6.4		30	21.5		21	44.5
	16		37	7.0		29	29.7		21	59.0
	22	8	13	13.6		24	59.7		23	39.3
	29	7	45	26.6		21	0.3		25	3.9
	30		41	28.6		20	33.6		25	7.3
Nov.	2	7	29	36.2		19	22.4		25	41.2
	12	6	50	9.6		17	29.7		26	9.8
	14		42	17.8		17	29.6		26	9.1
	18		26	35.8		17	54.6		25	58.2
	20		18	45.6		18	19.1		25	42.0
	21	6	14	50.5		18	31.1		25	37.4
	26	5	55	18.1		20	19.9		24	56.5
	28		47	29.9		21	13.1		24	28.4
	29		43	36.3		21	16.6		24	16.7
	30		39	42.3		22	16.3		24	4.8
Dec.	6	5	16	18.7					22	27.0
	11	4	57	2.7		31	8.8		19	32.4
	13	4	49	14.9	334	32	8.4	-11	19	6.9

## METIS.

## LIVERPOOL.

## Equatoreal.

(Mr. Hartnup.)

1848-49.		Green. M.T.			R.A.			N.P.D.			Comput <sup>d</sup> .—Obs <sup>d</sup> . Stars of Comp.		
		h	m	s	h	m	s	°	'	"	R.A.	N.P.D.	B.A.C.
Dec.	30	5	57	14.2	23	3	28.06	100	52	53.0	-0.67	-2.8	7974, 8109
Jan.	7	6	13	3.2		15	50.05	99	19	11.3	0.34	4.1	8102, 8214
	13	5	55	59.4		25	23.21	98	6	53.9	0.41	3.1	8109, 8274
	17	6	28	41.3	23	31	56.09	97	17	29.9	-0.36	-8.4	— —

"The observations are corrected for refraction and parallax. The computed places were deduced from Mr. Graham's ephemeris. The places of the stars of comparison are taken from the catalogue cited."

HAMBURG.		Equatoreal.		(M. Rümker.)
1840.		Hamb. M.T.	R.A.	Decl.
		<sup>h</sup> <sub>h</sub> <sup>m</sup> <sub>m</sub> <sup>s</sup> <sub>s</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>
July	22	12 51 0'9	340 37 41'8	-17 18 4'7
	25	13 24 56'1	340 19 57'0	35 20'7
	28	12 18 38'0	339 58 44'9	17 52 56'8
	30	12 40 15'2	42 13'7	18 5 15'5
	31	13 59 59'8	32 18'9::	11 48'2::
Aug.	1	11 26 24'8	339 25 4'4::	18 17 16'3::
	11	11 38 26'5	337 34 45'0	19 23 41'1
	13	12 59 15'5		37 17'9 Mer. Circla.
	13	14 4 46'1	337 7 29'5	-19 37 28'7

## ASTRÆA.

HAMBURG.		Equatoreal.		(M. C. Rümker.)	
Hamb. M.T.		R.A.		Decl. Obs.	
1849.	<sup>h</sup> <sub>h</sub> <sup>m</sup> <sub>m</sub> <sup>s</sup> <sub>s</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	
Aug.	17 13 34 21'6	50	6 27'2	+ 12 45 41'9	
	18 13 36 43'3		19 47'0	46 46'6	
	19 14 17 45'5		33 25'2	47 45'1	
	20 13 37 34'1	50	45 59'0	48 29'9	
	25 13 21 45'6	51	46 25'9	51 11'4	
Sept.	11 15 6 4'0	54	21 33'9	40 32'9	5
	12 11 54 6'0		26 49'5	39 30'6	4
	14 13 26 45'2		38 33'2	36 28'1	12
	15 11 36 37'8	54	43 18'7	34 33'0	1
	20 11 22 38'4	55	3 11'9	24 14'4	12
	21 11 22 9'0		5 59'1	21 48'7	14
	22 11 1 29'5		8 35'2	19 14'4	3
	23 12 37 48'4	10	36'6	16 36'3	15
	24 16 5 19'9	12	17'3	13 39'0	14
	25 11 17 26'0	13	27'0	11 21'5	5
	26 11 29 56'0		14 10'8	8 26'3	5
	27 11 22 10'3	55	14 36'8	12 5 22'4	17
Oct.	10 10 41 57'2	54	41 48'4	11 19 20'6	4
	13 9 44 1'2		24 20'3	6 27'0	3
	14 9 31 3'0		17 35'3	11 2 33'5	10
	15 9 50 45'4		10 15'9	10 58 10'9	10
	16 10 48 50'2	54	2 26'4	53 28'4	7
	18 12 3 8'0	53	45 28'7	44 20'8	8
	19 9 5 9'3		37 34'9	40 16'1	8
	22 9 48 58'7	53	9 3'2	26 25'6	8
	25 9 55 54'7	52	37 44'4	12 9'3	1
	27 9 59 38'3	52	14 49'5	+ 10 2 44'9	19

1849.		Hamb. M. T.	R. A.		Dec.	Obs.
		<sup>h</sup> <sub>h</sub> <sup>m</sup> <sub>m</sub> <sup>s</sup> <sub>s</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>	
Nov.	5	9 48 24.5	50 19 32.0	+ 9 20 24.2	7	
	6	9 48 28.6	50 5 55.3	15 59.0	10	
		12 16 2.5	4 15.8	28.5	Mer. Circle.	
	7	8 34 9.3	49 52 44.7	9 11 40.4	8	
	12	8 12 53.6	48 41 34.6	8 50 17.0	8	
		11 46 47.8	39 13.6	49 42.9	Mer. Circle.	
	14	7 57 41.2	48 12 35.6	42 2.6	3	
	18	11 17 28.8	47 13 2.7	26 57.0	Mer. Circle.	
	21	10 34 10.6	46 31 30.7	17 18.1	5	
		11 2 52.8	30 54.7	3.6	Mer. Circle.	
	23	9 53 51.7	46 4 1.3	11 17.4	6	
	25	10 43 34.1	45 35 9.3	6 5.7	Mer. Circle.	
Dec.	26	7 41 11.0	45 25 28.8	8 3 38.7	11	
	4	10 28 18.0	43 48 42.1	7 49 32.4	10	
		10 0 58.6	38.1	33.8	Mer. Circle.	
	5	9 16 24.0	38 39.2	48 38.9	6	
	6	7 47 34.0	43 29 5.6	47 52.5	12	
	11	8 16 59.0	42 43 31.0	46 25.3	10	
	12	7 40 43.0	35 48.7	46 35.1	14	
		9 24 37.9	6.2		Mer. Circle.	
	13	8 10 5.0	42 28 10.5	7 47 0.4	14	
		9 20 12.2	27 36.4	46 56.9	Mer. Circle.	
	22	8 9 26.0	41 53 8.6	+ 8 2 48.1	6	
1850. Jan.	2	6 52 15.5	41 31 50.7	+ 8 30 58.0	10	
	3	8 39 16.2	33 58.2	35 6.4	7	
	6	6 51 32.3	41 42 14.5	8 47 5.2	15	
	12	9 35 48.1	42 10 39.2	9 15 19.8	14	
	14	10 58 28.0	42 45 2.7	26 50.2	12	
	19	9 5 21.2	43 4 13.8	+ 9 54 3.8	10	

The observations are *not* corrected for parallax.

*Mean Places for January 1, 1849, of the Stars compared with Astræa, deduced from Observations with the Meridian Circle near the Time of Comparison.*

	R. A.		Decl.	Obs.		R. A.		Decl.	Obs.
	<sup>h</sup> <sub>h</sub> <sup>m</sup> <sub>m</sub> <sup>s</sup> <sub>s</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>				<sup>h</sup> <sub>h</sub> <sup>m</sup> <sub>m</sub> <sup>s</sup> <sub>s</sub>	<sup>o</sup> <sub>o</sub> <sup>'</sup> <sub>'</sub> <sup>"</sup> <sub>"</sub>		
2	47 14.99	+ 7 31 11.5	3 12 26.44	+ 8 29 6.5					
48	9.45	46 15.9	13 41.19	41 13.7					
49	52.08	33 36.5	16 41.30	8 29 35.7					
50	7.15	44 4.1	17 3.01	9 9 14.4					
53	46.39	33 9.7	18 59.46	9 12 8.0	2				
2	54 44.06	7 52 31.2	20 21.30	10 51 52.1	3				
3	1 21.14	8 6 2.2	21 15.06	9 25 58.1	3				
6	36.31	25 51.8	21 50.83	10 51 51.4					
3	10 37.27	+ 8 46 59.8	3 21 58.50	+ 12 22 50.4					

R.A.			Decl.	Obs.	R.A.			Decl.	Obs.				
h	m	s			h	m	s						
3	22	9.63	+10	48	56.4	2	3	35	12.88	+10	41	50.4	
	22	13.85		9	56	11.1		35	42.96	11	21	8.8	2
	22	32.55		12	24	55.7		35	53.73	8	34	4.2	
	23	35.27		8	14	42.1		36	19.67	10	39	24.8	
	24	13.05		10	13	6.6	3	36	24.70	9	42	26.4	
	25	33.53		9	10	15.1		36	29.75	11	26	3.4	2
	26	13.93		8	9	6.8		37	13.51	12	45	55.4	
	26	48.94		10	32	12.2		37	52.08	10	4	20.4	
	27	1.69		10	53	19.9		37	56.64	12	39	56.6	
	28	18.58		9	40	55.6	5	38	18.67	11	3	40.7	
	28	23.32		12	47	16.4	5	38	32.52	10	42	42.1	
	28	34.90		9	17	48.6		38	33.07	11	11	46.0	
	29	58.77		8	38	55.0	2	38	43.44	12	38	7.2	
	30	55.81		10	35	36.0	2	39	4.04	12	2	11.1	
	31	16.56		8	34	8.1	2	39	59.61	10	40	28.6	3
	31	45.71		11	37	46.7		41	6.28	12	26	40.1	
	31	47.97		12	42	14.7		41	23.57	12	8	12.8	
	32	8.70		12	35	43.6		41	28.26	10	5	39.7	
	32	10.83		13	3	37.3		42	53.06	12	35	8.4	
	32	13.33		10	31	59.2		43	22.88	10	23	1.9	
	32	58.68		10	39	37.7		44	33.61	9	31	23.6	
	33	11.90		12	48	27.9		46	2.99	8	47	51.1	2
	33	19.84		9	35	33.1		50	20.32	10	35	26.5	
	34	29.17		8	8	57.3		52	19.15	12	3	34.0	
	34	34.03		11	28	25.3		3	55	56.10	+12	5	17.5
3	34	41.86		+12	34	6.4							

## Mean Places for January 1, 1850.

R.A.				Decl.				R.A.				Decl.			
h	m	s	°	°	'	"		h	m	s	°	°	'	"	
2	44	50.07		+7	59	29.0		2	48	24.51		+9	30	56.8	
	45	43.22			8	43	12.2		48	56.37		9	33	27.0	
2	47	19.72		+8	42	58.9		2	51	44.01		+9	54	7.8	

The small figure at the end denotes the number of observations.  
Where there is no number, only one observation has been made.

*On the Phenomena attending the Disappearance of Saturn's Ring.*  
By the Rev. W. R. Dawes.

"The interesting phenomena attending the disappearance of Saturn's ring in 1848, can scarcely have failed to attract the attention of the possessors of powerful telescopes in this country; but none, I believe, of the observations made have been presented to the Astronomical Society. From Professor Bond, however, a paper appears in the *Monthly Notices* for November 1849, containing

observations made on *Saturn* with Merz's large refractor at Cambridge, U.S.; and also some inferences which he deduces from them.

"My own refractor (then at Cranbrook) being employed on a regular series of micrometrical observations, was only occasionally turned on the planet. What was noticed, however, was usually recorded at the time in my observatory journal, though without any intention of publication; for it was imagined that the results of observations with far more powerful telescopes, reflecting and refracting, would doubtless appear in the *Monthly Notices*, and render my own superfluous. On a perusal of Professor Bond's paper, however, I find that I have noticed several interesting particulars not alluded to by him; and also that the deductions I have drawn from some of the phenomena observed by both of us differ greatly from his. I, therefore, beg to present to the Society the following extracts from my journal, with some remarks upon them.

"1848, June 30. *Saturn*. Power 252. The *ansæ* of the ring are *not quite* invisible. They are of a *deep coppery tinge*; and on the following arm is a faint satellite. I get an occasional glimpse of a similar appearance on the preceding arm, but cannot decidedly verify it. The planet is more than  $2\frac{1}{2}$  hours east of the meridian. On looking again carefully with powers 252 and 163, I cannot be certain of either of the points *upon* the ring; for the *ring itself* seems *brighter* in those parts; and I question whether it be not a small portion of the ring which reflects more light. On estimating carefully, I find the part must be about *the extremity of the inner ring*, which is its brightest part.

"July 15. The ring is visible, *with the two dots* [bright points] *on it as before*.

"August 9. Occasionally an exceedingly faint *dusky red* line extends on each side of the shadow on the ball [being the arms of the ring].

"August 20. The shadow of the ring on the ball is very narrow. *The arms of the ring not visible*.

"Sept. 1. Power 163. Excessively narrow shadow of the ring on the ball. Belts strong, especially the two parallel ones in the northern hemisphere. *No trace of the ring*.

"Sept. 2. 11<sup>h</sup> G. M. T. Power 163. *The ring is visible as an excessively narrow line of nearly the same colour as the planet*. The *Nautical Almanac* gives Sept. 3 as the time of its reappearance. *No shadow* on the ball.

"Sept. 3. Power 188 [an equiconvex single lens]. The ring is bright, though rather duller in colour than the planet. There is a *dusky* line about the same degree of shade as the belts (which are strong to-night), crossing the ball precisely in the line of the ring. It is very different from the *shadow* of the ring. Is it the *ring itself*, which, being less bright than the planet, is visible on the ball; as *Jupiter's* third and fourth satellites are visible on his

disk as they transit over it? Night fine. *Enceladus* very well seen, and watched nearly up to the preceding arm.

“Sept. 4. Ring much brighter than last night. The dusky shade across the ball is visible, but not so distinct as it was last night. The following arm appears decidedly longer than the preceding one.”

“A few days after the last observation, I went to Starfield on a visit to Mr. Lassell, and on every opportunity that offered observed *Saturn* with his powerful 20-foot reflector. The following are some of the memoranda entered in my journal.

“Sept. 12. 11<sup>h</sup> 20<sup>m</sup> M.T. The ring is the finest line imaginable, yet of a pretty clear bright planetary colour.

“Sept. 13. *No ring visible, nor shadow.*

“Sept. 14. No ring visible. There is a very narrow dusky line [on the ball] just south of the bright equatoreal region.

“Sept. 19. The ring is *just visible* when the planet is best seen.’ [It was frequently noticed to-night during the series of observations which placed beyond doubt the satellite-nature of *Hyperion*.]

“The subsequent observations were made after my return to Camden Lodge, Cranbrook, with my 8½-foot achromatic.

“Oct. 6. No decided appearance of the ring on either side. 9<sup>h</sup> 45<sup>m</sup>, *Tethys* has occulted *Enceladus*. The planet is exquisitely seen. The line across the ball is very sharply defined and black, though I thought not quite *uniformly* so; the northern edge appearing blacker than the southern. [The *obscure* surface is now turned towards the earth.]

“Oct. 11. The arms of the ring are *frequently visible*, especially that on the *following* side, which is far more steadily seen than the other.

“Oct. 26. Exquisite vision. Glimpses of a *division in the dark shade on the ball.*

“Oct. 30. I have several times this evening received the impression of the dark line across the ball being *divided by an excessively fine line of light*, perhaps a trifle north of its middle. Most frequently suspected with powers 323 and 460.

“11<sup>h</sup> 30<sup>m</sup>. *Enceladus* is at the end of the following arm very nearly. There is a pretty bright dot *on* the following arm, and a similar one on the preceding arm.”

“Nov. 21. Very fine night. *Enceladus* was seen the instant the object was brought into the field of the *double-image* micrometer, power 435; and when the image was divided, the two points were still distinctly visible; proving that the telescope will

\* The night of Oct. 30 was very fine. *Enceladus* was bright with power 460, and was easily watched nearly up to contact with the following arm of the ring. Its distance from the planet's centre was measured with the parallel-wire micrometer under slight illumination of the field. At 7<sup>h</sup> 16<sup>m</sup> 30<sup>s</sup> G.M.T. the distance was 34".40 by four observations. With 460 and 658 the two bright satellites of *Uranus* were steadily seen.

shew a lucid point of *half the brightness of Enceladus*. The dark shade [on the ball] is occasionally seen *divided by a bright and excessively narrow line*. The planet bears 460 very well.

“ ‘ Dec. 5. The ring is curiously broken into portions, which look almost like small satellites. Occasionally, the planet is very well seen.

“ ‘ Dec. 20. The ring is obvious enough, but is broken, especially on the following side.

“ ‘ Dec. 21. The ring is reduced to a very fine line, occasionally appearing broken, but sometimes entire. The eastern arm is not quite so bright as the western.

“ ‘ 1849, Jan. 6. The ring is scarcely ever visible, but occasionally in the best moments it may be traced nearly or perhaps quite to the extremity. But some portions of it are brighter than others.’

“ At this time the earth was elevated about half a degree to the *north* above the plane of the ring; the sun being about  $1^{\circ}8$  to the *south* of that plane. On the 19th, the earth passed from the northern to the southern side of the plane of the ring; and the *bright* surface became visible. Cloudy weather precluded observations till the 22d.

“ ‘ Jan. 22, 7<sup>h</sup> 12<sup>m</sup>. *Titan* is in contact with the southern side of the following arm, and about two-thirds of its length from the edge of the planet. The *ring* is bright, though narrow. *It is very much brighter in two places similarly situated on each arm*; and they coincide with the extremities of the inner and outer ring.’

“ *Titan* was distinguishable from the brighter parts noticed when observed at 7<sup>h</sup> 12<sup>m</sup>. It afterwards came into coincidence with those on the following arm as it moved along it.”

#### Remarks.

“ 1. From the observations above detailed, it is obvious, that when the *obscure* side of the ring is turned towards the earth, it is not invisible with moderate optical power. It also appears that *its visibility diminished* as the earth approached its plane, and its edge, consequently, was turned directly towards us. This is proved by the increased *difficulty* of seeing it with my refractor on Aug. 9, compared with July 15; between which dates the minor axis of the ring had considerably diminished; by its *invisibility* on Aug. 20 and Sept. 1, when the earth was very nearly in the plane of the ring; and by the increasing *facility* with which it was observed between Oct. 11 and the end of November, during which interval the minor axis had increased. And it is still more conclusively shown by the *total invisibility* of the ring even with Mr. Lassell's 20-foot reflector on Sept. 13th, when both the earth and the sun were very nearly in the plane of the ring, and consequently the sun's light would be reflected from its *edge* with scarcely any obliquity.

“ Hence it may be inferred that the *edge* of the ring reflects extremely little light, and that the visibility of the ring, when its

obscure side is turned towards the earth, does not arise from the sun's light reflected from the *edge*, but from a feeble illumination of the *obscure surface*; and that it is *this surface only* which is seen, and not the edge.

" This conclusion is supported by the appearance of *bright points* in some parts of the ring when obscurely visible; those points remaining *stationary*, and not partaking of the rotation of the ring. That inequalities should exist on the *edge* of the ring so large as to appear like satellites, even with a moderate telescope, when the edge itself, though directly turned towards us and fully illuminated, was quite invisible with a reflector of 24 inches aperture (whose illuminating power is about equal to that of an achromatic refractor of 17 inches aperture), seems to be quite inadmissible.

" It may be inferred, therefore, that the appearance of bright points in the unilluminated ring arises from the greater reflective power of some portions of its *surface*: the exterior portion of the inner ring being usually the largest and brightest of all, and visible on both arms at equal distances from the ball. The brightness of these points was not always precisely the same on each side: at some times the eastern, and at other times the western, appearing the brighter. This may readily be accounted for by supposing that the ring, at a given distance from its centre, may not possess the same degree of reflective power throughout its whole circuit: indeed, it is scarcely probable that it should; and the observed fact is in perfect harmony with the *rotation* of the ring, which the stationary appearance of irregularities on the *edge* can scarcely be.

" 2. The inquiry is interesting, *Whence is the light derived which renders the obscure surface of the ring visible?*

" On this subject Sir W. Herschel says (in a paper read before the Royal Society, Nov. 12th, 1789), ' I may venture to say, that the ring cannot possibly disappear on account of its thinness; since, either from its edge, or the sides, even if it were square on the corners, it must always expose to our sight some part which is illuminated by the rays of the sun: and that this is plainly the case we may conclude from its being visible in any telescopes during the time when others of less light had lost it, and when evidently we were turned towards the unenlightened side; so that we must either see the rounded part of the enlightened edge, or else the reflection of the light of *Saturn* upon the side of the darkened ring, as we see the reflected light of the earth on the dark part of the new moon. I will, however, not decide which of the two may be the case, especially as there are very strong reasons to induce us to think that *the edge of the ring is of such a nature as not to reflect much light.*'

" Relinquishing then the idea of the visibility of the mere edge of the ring (whether from its extreme thinness or its unreflective nature), it may be asked, ' Do the appearances warrant the conclusion, that the obscure surface is rendered visible by the reflexion to us of the light reflected upon it by *Saturn*?'

" If this were the case, might we not reasonably expect that its

*colour* would be somewhat similar to that of the obscure portion of the moon as enlightened by the earth? It is, however, of a totally different hue, and strongly resembles the *tarnished copper* colour frequently assumed by the moon under a total eclipse. May it not also be fairly questioned whether the ring would be so brilliantly illuminated by the reflected light of *Saturn* (which must fall but feebly on the half of the ring farthest from the sun), as to cause small portions of it to rival in brightness the satellites themselves illuminated by the direct rays of the sun: the brightest points of the ring (the eastern and western extremities) receiving reflected light from *one-half only* of the illuminated surface of *Saturn*, which would be seen from them as a *half-moon*?

"I would venture, therefore, to suggest, that the illumination of the obscure surface of the ring arises from the *refraction of the sun's light through an atmosphere surrounding each of the rings*, and thus throwing a pretty strong *twilight* upon them. During the whole time that the obscure surface was turned towards the earth, the sun was not more than two degrees below its plane; and during the period embraced by the observations, the depression scarcely ever amounted to one degree. A very moderate density of atmosphere, therefore, might suffice to produce considerable illumination of the obscure surface; much greater, probably, than the reflected light of *Saturn* could give, and of a far *ruddier tinge*, more nearly resembling that of our western sky shortly after sunset.

"3. It was occasionally observed, and on Oct. 6th it is recorded, that the dark shade on the ball was not uniformly black, its *northern* portion being *black*er than the southern. On three unusually fine nights, viz. Oct. 26th, Oct. 30th, and Nov. 21st, this shade was seen to be divided through its whole length into two parts by an excessively fine bright line. After scrutinising the object for a long time with high powers, I remained perfectly convinced of the fact, which I can account for only by supposing that the northern and blacker portion was the shadow of the ring cast by the sun upon the ball; that the somewhat lighter shade was the ring itself seen projected upon *Saturn*; and that the bright line between the two was a portion of the equatorial regions of the planet. The relative situations of the different bodies at the time renders, I think, such an explanation probable."

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*On the Past History of the Comet of Halley.* By Mr. J. R. Hind.

It is well known that the periodicity of the remarkable comet which bears the name of Halley was inferred by that astronomer from a comparison of three sets of elements, calculated on observations of the comets of 1531, 1607, and 1682. When his table of cometary orbits was first published, Dr. Halley says he was content to hint at his conjectures respecting the identity of the comets of those years as having some degree of probability, and to advise pos-

terity carefully to watch for its return about the year 1758. At a subsequent period, an examination of the catalogues of ancient comets showed that three others had preceded those already mentioned, "manifestly in the same order and at like intervals of time, viz. in the year 1305 about Easter; in the year 1380, the month unknown; and, lastly, in the month of June 1456;" and on making this discovery Dr. Halley says he became much more confirmed in his former opinion. Want of data, however, prevented his ascertaining beyond doubt that the comet of 1682 had appeared in any of the three years, 1305, 1380, or 1456, and he had little or nothing but equality of intervals on which to found his belief.

M. Pingré, after collecting together the immense mass of records from which his great work the *Cometographie* is constructed, was enabled to convert into a certainty Halley's supposition respecting the appearance of his comet in 1456. Two definite observations of the position were found, the one at Vienna, mentioned in an Austrian chronicle by Ebendorffer, the other at Rome, preserved in a manuscript treatise on the comet of 1468, to which Pingré had access in the Bibliothèque du Roi at Paris. The comet was in perihelion on the 8th of June at 22<sup>h</sup>, Julian style.

The preceding appearance was referred by Halley to 1380, but M. Laugier has shown that it took place in the autumn of 1378, under nearly the same circumstances as in 1835. The Chinese observations fix the time of passage through perihelion on November 8<sup>d</sup> 18<sup>h</sup>.—(*Conn. des Temps*, 1846.)

In a paper on the history of the comet of Halley, published in the *Comptes Rendus* for 1846, July 27, M. Laugier has recognised this body in 760 and 451. The elements calculated by Burckhardt for the comet observed by the Chinese in 989 approached so close to that of Halley's Comet, that some suspicion of their identity has been entertained. But I believe, with these exceptions, the returns which I am about to mention as either certain or probable have not been previously noticed. The valuable details existing in the annals of China, and but recently known in Europe, enable us to trace this famous comet with a high degree of probability to the year 11 before the Christian era,—a most important circumstance, not only as regards the history of this particular comet, but as bearing on the constitution of these bodies in general. I shall merely state here the results to which I have been led by a close examination of the *Cometographies* and Chinese records, without extending this notice to an inconvenient length by the insertion of details. The data which I have had to work upon are found in the *Cometographies* of Pingré, Hevelius, and Lubienietzki, Ma-tuoan-lin's catalogue of comets and extraordinary stars, and the other Chinese authorities with which we are acquainted through the labours of M. Edouard Biot.

The comet of Halley having returned to its perihelion in 1378, we may expect to find some mention of it about the year 1301; and notwithstanding the anomalous character of the results obtained by MM. Burckhardt and Laugier for the first comet of that year, I

am pretty well convinced it was no other than the comet of Halley. The Chinese account, which is tolerably definite, is exceedingly well represented by the elements of that body: assuming the perihelion passage to have occurred on October 22<sup>d</sup> 16<sup>h</sup> Greenwich time, the comet passed through *Gemini*, south of *Ursa Major*, and finally traversed *Serpens* and *Ophiuchus*, being lost in the twilight at the end of October or beginning of November. There is one European account, however, which is not so easily reconciled with this supposition. It is that of Friar Giles, whose description has led M. Laugier to an orbit differing considerably in the position of the line of nodes from that of Halley's Comet. Now, had this Friar Giles established for himself a reputation as an exact and consistent recorder of facts, we might justly entertain serious doubts as to the identity of the comet of 1301 with Halley's; but in his account of another comet (that of 1264) he contradicts himself so manifestly in the same paragraph, that we may fairly question his ability to describe accurately what he saw. Even in the case before us there is some confusion, and M. Laugier has been obliged to admit an alteration, which produces a contradiction in Giles's account, in order to reconcile the main part of his description with the Chinese observations.

The question stands thus: Halley's Comet should have appeared in all probability about 1301. We find in that year mention of a comet whose apparent path, according to the Chinese historians, is well represented by the elements of Halley's Comet: the only objection to the identity that can be advanced rests on an observation of latitude by an European astronomer, or, rather, astrologer, whose description of another comet has been shown to contain a manifest contradiction, and who, in the very case before us, has committed one pretty decided error. I am strongly inclined to recognise in the first comet of 1301 Halley's famous star.

It will readily be understood that I have not the slightest intention to undervalue M. Laugier's investigation on this comet; there can be no doubt that if we admit the whole narration of Friar Giles, his orbit must be retained, and in that case we must conclude that the comet of Halley passed its perihelion about the year 1301, unobserved, or, at least, unrecorded.

The preceding return of the comet took place, I think, in 1223, in the month of July, shortly before the death of Philip Augustus, as French historians state. It was seen for eight days at the beginning of July in the evening twilight. The Chinese have no mention of this comet, and it unfortunately happens that European chronicles give very vague accounts of it, so that we cannot come to any definite conclusion respecting its identity with Halley's. All that can be said is, that the few particulars we possess agree perfectly well with the position of Halley's Comet in the heavens when the perihelion occurs in July, and that the comets of the preceding and following year, observed in China, appear to have had very different elements. It is therefore most likely that our comet was in perihelion in July 1223.

In 1145 the return of the comet of Halley seems to me little less than a matter of certainty. On carrying back the elements to that epoch, and fixing the perihelion passage on April 19, the whole of the particulars left us by the European and Chinese authors are exactly represented. Its discovery in the morning twilight about April 15, its increasing brilliancy towards the end of the month, the disappearance about the first week in May, and rediscovery in the evening sky in the north-west on May 14th, and gradual fading away in *Hydra* on the 9th of June, are fully explained, the positions agreeing perfectly.

The periods of revolution between 1145 and 1456 average  $77\frac{1}{2}$  years, and if we reckon backwards a like interval from 1145 we arrive at the year 1067, about which epoch we may expect to recognise the comet again.

There is vague mention in several European chronicles of the appearance of a comet at the time of the death of Constantine Ducas, in May 1067. We have no particulars, and even the reality of the comet is subject to some doubt. In 1066, a year memorable in English history as that of the Norman Conquest, a very grand and remarkable comet is recorded by nearly every chronicler and historian of the age. It was observed throughout Europe and China during the months of April and May. The elements of Halley's Comet, as they at present exist, will hardly represent these circumstances with a sufficient degree of accuracy; but if we assume the following numbers we shall have a very fair agreement between observation and calculation :—

Perihelion Passage 1066, April 1<sup>d</sup> 0<sup>h</sup>, Greenwich Time, Julian Style.

Longitude of Perihelion .....	264° 55'
Ascending Node .....	25° 50'
Inclination .....	17° 0'
Least Distance .....	0.72
Motion Retrograde.	

In this orbit the longitude of perihelion is further in advance than that of the present orbit of Halley's Comet by  $30^\circ$ , and the node by  $17^\circ$ : the perihelion distance is greater by 0.14. But are these differences to be considered beyond the limits of probability? in the lapse of so many centuries may not the planetary perturbations have produced alterations in the elements at least equivalent to those here exhibited, especially since there is good reason to conclude that the plane of the orbit of Halley's Comet formerly coincided much more closely with the plane of the ecliptic than at present, the comet being, therefore, subject to far larger perturbations than it has undergone in more recent times?

The elements which I have assumed for the comet of 1066 have been obtained partly from the observations in that year and partly from the Chinese description of a comet A.D. 141, which also agrees with the supposed period of Halley's. *The same orbit will represent the apparent paths in both years*; and I would particularly insist on this point as one of some importance in the present inquiry.

I may also remark, that it appears by no means improbable that an orbit more closely resembling that of Halley's Comet might be made to represent the circumstances recorded of the comet of 1066 with tolerable accuracy. The descriptions of this object are so confused that a good deal of uncertainty is necessarily attached to any conclusion we may deduce from the observations.

The preceding return of Halley's Comet took place, I think, in 989, and Burckhardt's calculations relative to the comet observed in China in that year strongly support this idea. The perihelion passage would occur about the 12th of September.

In 912 a comet was seen in China in the month of May in *Leo*, near the star marked  $\chi$  on our charts. It was also perceived in Europe. The orbit of Halley's Comet, with very trifling alterations, will agree with the above position about May 13 or 14, if we fix the perihelion at the beginning of April.

The preceding appearance of the comet should fall about 837, in which year a most splendid comet was observed both in Europe and China. The elements of this body, calculated by Pingré, exhibit a general similarity to those of Halley's Comet, with the exception of the node, which is almost diametrically opposite. Now Pingré conjectured, as he himself states, that the comet passed the *ascending* and not the *descending* node on the 10th of April, or otherwise it could hardly be said to move in a north-west direction on the 12th, as we learn from the Chinese relation. It is clear, from the position of the tail on the former date, that the head of the comet could not have been far from the ecliptic; and it appears to me that Pingré's conclusion is unavoidable, if we take into consideration the whole of the Chinese description, notwithstanding its laxity as regards the distances of the comet from the equator and the singularity of the circumstance that a comet should have become visible in the very year when Halley's would probably return to the perihelion, presenting in every element except the node a striking resemblance to the orbit of that interesting body. The comet of 837 which figures in our catalogues was, therefore, in all probability, different from Halley's, though the position and distance in perihelion and direction of motion were the same, and the inclination of the orbit (a most uncertain element in the present case) not very widely different for the two bodies.

The Chinese annals mention another comet in May and June 837, which was probably that of Halley. It is not unlikely that successive copyists have altered the original description of the path amongst the stars, and that the comets observed in *Gemini* and *Virgo* in these months were the same. For the Chinese accounts of the apparent tracks of comets present frequent instances of want of chronological arrangement: thus, a date is occasionally mentioned as the epoch of discovery, and a position corresponding to a subsequent time immediately follows. If we may interpret the Chinese description, so as to place the discovery of Halley's Comet in *Gemini* on April 29, and to refer the positions in *Leo* and *Virgo* to that body at a subsequent date, it will be easy to reconcile the

apparent path with calculation, supposing the perihelion passage to have occurred early in April.

If the comet of *Gemini* and *Leo* was not that of Halley, probably this object was missed altogether at this return.

M. Laugier has shown in the most satisfactory manner that the observations of the comet of 760 in Europe and China are perfectly represented by the orbit of Halley's Comet, the perihelion falling on June 11. This year accords with my intervals. The return of the comet in 760 appears to me little short of a certainty.—(*Comptes Rendus*, 1846, July 27.)

In September and October 684 a comet was seen in China in the western heavens; but no further particulars are given. If Halley's Comet reached its point of least distance from the sun in October, it might have been observed in this position in September and the early part of October.

The previous return should have taken place about the year 607, and the Chinese annals have several comets in that year. I find, by actual computation, that none of them present any decided indications of identity with the one which forms the subject of these remarks, and I am therefore inclined to fix its reappearance in the following year, 608, when a comet is mentioned by Matouan-lin, though (most unfortunately) he has omitted to state the days to which his positions apply. The path attributed to this body, from *Auriga*, through the lower part of *Ursa Major*, into *Scorpio*, where the comet vanished, is precisely that which Halley's Comet must follow when the perihelion takes place in October or early in November. This circumstance, and the close agreement of intervals, appear to render it highly probable that the Chinese observed the comet of Halley in 608.

After a careful examination of the particulars related of the comets of 530 or 531, which Newton and Halley, owing to the want of precise data, recognised as that of 1680, I find the whole of them may be explained by the elements of Halley's Comet, supposing it to have been in perihelion early in November. Yet this inference is necessarily open to considerable doubt, and I am very far from insisting upon it. Of one point I have become pretty well convinced by my calculations, viz. that the comet of 530 or 531 (for the year of appearance is doubtful) was not identical with the celebrated one of 1680. Pingré seems to have suspected this, though he has endeavoured by alteration of dates or positions to show that such identity may have been possible. Where, however, we find the accounts of a comet as they stand in the original authorities reconcilable with a single orbit, it is surely unfair to alter them in any way, so as to produce an agreement with some preconceived notions.

In 451, or at an interval of about 79 years from 530, a comet was observed in Europe and China. It appeared about the time of the Battle of Chalons, when Attila was defeated by the Roman General Aetius. On May 17 the Chinese saw it near the *Pleiades*, and followed it till July 13, when it was situate near  $\beta$  *Leonis*.

Assuming Halley's Comet to have arrived in perihelion on July 3 at midnight, M. Laugier finds a remarkable agreement between the observed and calculated positions, and there can remain but little doubt that this body was seen in 451.

Seventy-eight years previous, or in October 373, 24th day, the Chinese mention a comet in *Ophiuchus* and *Serpens*. Suppose our comet to have been at its least distance from the sun early in November, we shall find it would be located in *Ophiuchus* on the 24th of October. The account is too vague, however, to allow of any definite conclusion.

Deducting another period of 78 years, we arrive at the year 295, and at this epoch I find recorded a comet in Ma-tuoan-lin's catalogue which has every appearance of identity with Halley's. The path assigned by this historian is exactly represented by the orbit of Halley's Comet, assumed to be in perihelion at the commencement of April. It passed through the lower part of *Ursa Major*, *Leo*, and *Virgo*, having been previously seen with the same right ascension as the constellation *Andromeda*. A comparison of the track in 295 with the paths followed by the comets in 451, 760, and 1456, will sufficiently justify the inference that the observations of the year 295 really belong to the comet of Halley.

Another interval of 77 years from this epoch brings us to the year 218, when this famous body should have visited us again, and it is an important fact that the Chinese annals mention a comet in 218, which there can scarcely be a doubt was the one in question. It was seen also in Europe shortly before the death of the Emperor Opilius Macrinus, who was killed on the 7th of June. Dion Cassius describes it as a very fearful star, and the Chinese tell us it was intensely brilliant. It passed through *Auriga*, *Gemini*, *Ursa Major*, into *Leo*, but was observed first in the morning in the eastern heavens. I fix the time of perihelion passage of Halley's Comet on April 6th, and find every circumstance recorded of the comet of 218 faithfully represented.

The preceding return fell, I think, in the year 141, and a fine comet is referred to that year by the Chinese historians. It was seen first in *Aquarius* and *Pegasus*, in the morning sky, about March 27, and about three weeks subsequently became visible in the evening, traversing *Taurus*, *Gemini*, *Leo*, &c. The elements of Halley's Comet, unaltered, do not quite agree with this track and the dates attributed to the various positions; but if we suppose the following orbit, depending on the observations of 1066 and 141 (as already mentioned), we shall have a very fair agreement:—

Perihelion, March 29.1.

Longitude of Perihelion	251° 55'	} Equinox of 141.
Ascending Node	12 50	
Inclination	17 0	
Least Distance	0 72	
Motion Retrograde.		

These elements have great resemblance to those of Halley's Comet, and it is very likely that an orbit differing still less might

suffice to produce a tolerable agreement. But few comets are recorded about this year, and none of them exhibit any indications of identity with Halley's, except that of 141.

In the catalogue of Ma-tuoan-lin we find a comet in the year 65, and another in 66, either of which may possibly have been Halley's, though I think the latter agrees better on the whole. It was discovered in January in the eastern heavens; on February 20 it had the same right ascension as the star  $\beta$  in *Capricornus*, and advanced to the south of *Scorpio*. These circumstances are in perfect accordance with the track followed by Halley's Comet when the perihelion passage takes place on January 26th.

The few particulars we have respecting the comet of A.D. 65 may be represented by the orbit of Halley's Comet, admitting it to have reached the perihelion on August 5th. It is possible, therefore, that the sword-shaped sign that was seen over Jerusalem at the commencement of the war which ended in the destruction of the Holy City by Titus, may have been the comet of Halley.

The most ancient, and, at the same time, one of the most certain apparitions of this body, took place in the year 11 B.C., reckoning according to the manner of astronomers. It was observed, according to Dion Cassius, under the consulate of M. Messala Barbatus and P. Sulpicius Quirinus, before the death of Agrippa, and seemed as though it were suspended over the city of Rome. The Chinese found it on the 26th of August in *Gemini*; it passed over this constellation, north of *Castor* and *Pollux*, towards *Leo* and *Virgo*, moving at the rate of  $6^\circ$  daily. Subsequently it passed near *Arcturus* and other stars in *Boötes* and arrived in *Ophiuchus* and *Serpens*. Fifty-six days after, August 26th, it set with  $\pi$  and  $\sigma$  *Scorpii*.

After the publication of M. Biot's valuable details in the appendix to the *Connaissance des Temps* for 1846, I attempted an orbit for this comet, and was immediately struck with the similarity of the elements to those of the comet of Halley. The only alteration necessary appeared to be a diminution of the orbital inclination, which, instead of  $17^\circ$ , would be more satisfactory at  $8^\circ$  or  $10^\circ$ . The Chinese description cannot be strictly followed, or we should have a very irregular path; but I am satisfied that the elements of Halley's Comet for perihelion, node, and least distance, and an inclination of  $8^\circ$ , will accord as well with the observations as any orbit can possibly do.

Previous to the year 11 B.C. the accounts of comets become so vague that it would be vain to attempt to carry the inquiry into more remote antiquity. I think it will be deemed a fact of considerable interest that the celebrated comet which bears the name of our countryman Halley may be traced, in a pretty satisfactory manner, as far back as the year 11 before the Christian era. For this extensive knowledge of its probable history we are mainly indebted to the records preserved in the annals of the various reigning dynasties in China.

*Investigation of the Parallax of Groombridge 1830.*

By M. Otto von Struve.

" I have just finished a series of observations and calculations on the parallax of *Groombridge 1830*, the star whose rapid proper motion was ascertained by Argelander in 1842. The method of observation followed by me in this research was that of measuring differences of declination between that star and two neighbouring stars; these I selected so that one of them (*b*) preceded *Gr. 1830* about 3 minutes in time and 3' to the north; the other (*a*) followed it by 2 minutes of time and about 0'5 to the south: (*b*) is of the tenth, (*a*) of the eighth magnitude. The second star is that which was used by M. Faye in his determination of the parallax. My observations began in 1847, Nov. 4, near to one of the minima of parallax in declination, and were finished 1849, Dec. 2, including in that space two minima and two maxima.

" The common method of observing differences of declination by equatoreals provided with wire-micrometers is well known. The operation begins by placing the wires in the direction of the daily motion, and observing the coincidence of the two wires, or the determination of the zero-point of the micrometer. Then the preceding star is brought to bisection by the fixed wire, by help of the micrometer-screw applied to the periphery of the declination-circle. This being done, it is supposed that the tube will not change its direction in declination between the transits of the two stars; and when the second star comes to the middle of the field, the moveable wire is brought, by help of the micrometer-screw, to bisect it.

" After the first day's observations, I remarked sometimes, especially in winter when the friction on the pivots is very heavy, that after having bisected the preceding star exactly, the instrument was a little changed in its position (not more, however, than some few tenths of a second) by a spring-like action of the arm, on which the declination-screw is directly applied. This action was immediately destroyed when, after having moved the tube with that screw in one direction, I gave it, at the end of the motion, a little turn in the contrary sense. But in proceeding in this manner I found great difficulty in obtaining the bisection of the star by the wire to the utmost visible exactness. To prevent this inconvenience, I had recourse to the following method of observation:—By help of the declination-screw I placed the star, in eastern horary angles, some tenths of a second (sometimes a little more or less) to the north of the wire, in western horary angles as much to the south, and observed the moment of the first good bisection, produced by the change of the refraction in different altitudes. To a horary angle of 5 hours corresponds, in our latitude, a zenith-distance of *Groombridge 1830* of  $50^{\circ}$ , with a change of  $7^{\circ}5$  for each hour. At that altitude the change of the refraction is about  $2''.4$  for each degree of the altitude; therefore, having placed the star about half a second from the wire, I had to wait 1.6 minutes of time till the best bisection was produced by

the change of refraction. This method of observation increases considerably the time employed, but at the same time it increases in a high degree the exactness of the results, and therefore I did not hesitate to follow this method for both stars in all cases where it was applicable.

"Near to the meridian this method of observation could not be used. Fortunately, in this position of the instrument, the motion of our refractor in declination is much smoother than in greater horary angles; therefore, in this case, I succeeded better in directing the wire on the star by the declination-screw; and in producing the bisection by turning the screw alternately in different senses, I was sure to avoid all constant errors. Nevertheless, I preferred the observations in greater horary angles; and in the later period of my observations I avoided, as much as I could, making them very near the meridian.

"I have mentioned already that I observed the moment of the first good bisection produced by the change of refraction. Owing to the trembling of the images, a good bisection will generally happen some seconds of time before the moment of exact bisection, that is, before the jumps of the star produced by the state of the atmosphere will be equal on both sides of the wire; but if I had waited for that so-called moment of best or exact bisection, I should have lost most probably a great many observations. For this reason I decided to observe the moment of first good bisection. The trembling of the images will be generally constant during two hours (the time employed for one evening's observation of *Groombridge 1830*), or at least it will change proportionally to the time. In both cases its influence will be eliminated in the difference of the two observed differences of declination, as soon as the observations are symmetrically arranged. On the contrary, in the sum of the two observed differences of declination, it will enter equally for both stars. As in our case, the preceding stars were both to the north of the following; in eastern horary angles the differences of declination observed by me ought to be a little smaller than those observed to the west of the meridian. This predicted phenomenon has been completely confirmed by experience. With only two or three exceptions, I have found the sum of the two observed  $\Delta\delta$ , or the differences of declination between the two stars of comparison, which ought to have been constant if they did not change their relative position in the heavens, constantly a little smaller at the east of the meridian than at the west, while, again, in their differences no trace of a constant difference is to be discovered. With a good harmony between the single determinations, the mean differences in the sum of the two  $\Delta\delta$ , measured on both sides of the meridian, is  $0''.31$ ; so that we have, for the mean effect of the trembling of the images on the bisection of one star, the value  $= 0''.08$ .

"Another kind of error in the measured  $\Delta\delta$  of two stars may arise, when, in the interval between the transits of both stars, the tube has changed its direction in declination by the effect of tem-

perature, of more or less hygrometric state of the atmosphere, or for any other unknown reason. If such a change takes place, its action can generally be assumed to be proportional to the time elapsed between the two transits; and consequently, the difference of the two  $\Delta \delta$  for a star situated in right ascension exactly in the middle between the two stars of comparison, would be quite free from that influence. In our case, the principal star was situated at a distance of  $3^m.1$  from the preceding, and of  $2^m.0$  from the following star of comparison; therefore, to avoid the errors produced by such a change, in the supposition of its proportionality to the time, we had to divide its total amount, on both observed  $\Delta \delta$ , in the proportion of 2 : 3. In some instances, there is no doubt, such a change has really taken place in our instrument; but its mean effect on the sum of the two  $\Delta \delta$ , or in the space of more than 5 minutes, deduced from the comparison of the single determinations with their mean, does not exceed  $0''.23$  for one day's observation. This number, as I have deduced it, ought to be found rather too great, as it includes all accidental error of observation. Its smallness, I think, is the best proof of the steadiness of our refractor.

"The exactness of measured distances, and likewise of measured  $\Delta \delta$ , with the wire micrometer, depends principally on the quality of the micrometer-screw. With the purpose of examining if the screw used by me was regular in all its parts, I brought it under a powerful microscope, and, having placed the wires of the microscope at a distance equal to 5 and 10 revolutions of the screw, I examined all different parts of the screw, and found them all so nearly equal one with another, that no measurable difference could be discovered in any part of the screw. Besides, to avoid more completely all possible error produced by an irregularity of the screw, or by an error in the division of the head of the screw, I never retained on two following nights the same zero-point, but continually changed it, so that all the different parts of the screw were used.

"The mean value of one revolution of the screw, and the influence of temperature on it, had previously been carefully determined. The method followed in this determination is explained in the *Description de l'Observatoire Central de Poulkova*, p. 193. The final value of one revolution of the screw was fixed there to be  $r = 9''.7319 - 0.00022 t$ , where  $t$  signifies the temperature given in degrees of Réaumur. This determination of the influence of temperature on the value of our screw was, however, of no great importance for the determination of the parallax of *Groombridge 1830*, as the maxima and minima of the parallax in declination for that star occur in the months of April and October. The mean of the temperatures during the observations in the months adjacent to each epoch was  $-1^{\circ}.1$  R. for the maximum, and  $-4^{\circ}.8$  R. for the minimum of the parallax; so that the action of temperature on the determination of the parallax, if its whole coefficient had been neglected, would scarcely have produced an error of  $0''.01$  on the final value; therefore, if a small error should yet subsist in the

indicated coefficient of temperature, its influence on the deduced parallax might be regarded as insensible.

"The coincidence of the wires, or the zero-point of the micrometer, was not subject to the least uncertainty. Every day it was determined 8 times, to make sure that no change had taken place in the position of the fixed wire. The method followed herein was to bring the moveable wire in contact with both sides of the fixed wire, and to take the mean of the two corresponding indications of the micrometer-screw. The single determinations got in this manner, and compared with their mean values, prove that the probable error of the mean, for one evening, is inferior to  $0''.01$ .

"To the foregoing remarks on the methods of observation I might also add that every day, before I began a series of observations, the focus, as well of the object-glass as that of the eye-piece, was carefully adjusted to coincide with the plane of the wires. Perhaps in the first part of my observations I did not give the necessary attention to this point; and for this reason I have much more confidence in the later part of the observations, made since the autumn of 1848, than in the first part. Besides, it must be remembered that in this case, as well as in all particular inquiries of practical astronomy, where new methods of observation are used, for every observer some patience will be wanted before he can have acquired the necessary experience in the manipulation of his apparatus for that particular purpose, and before he will be quite satisfied with his observations.

"The power employed in this research was No. 2 of our refractor = 207 times. The difference of declination for the star preceding *Groombridge 1830* being 3 minutes, a higher power could not be employed, if I wished to have both stars pass through the central part of the field, where, from the construction of our eye-piece, the images are the best defined; but I feel sure that if, in any other analogous inquiry, higher powers were to be used, the exactness of the observations would still be increased.

"A regular complete set of observations for one evening contained 8 comparisons of *Groombridge 1830* with each of the two stars. If we denote the observed differences of declination between *Groombridge 1830* and the star *a* by  $\Delta$ , those between *Groombridge 1830* and *b* by  $\Delta'$ , the comparisons were arranged in the following manner:—At first I observed, with the micrometer-screw to the south, four  $\Delta$ ; then, in the same position of the screw, four  $\Delta'$ . This being done, the position-circle was turned  $180^\circ$ , so that the micrometer-screw was brought to a position opposite to the first, and then the observations were continued in the inverse order, namely, at first four  $\Delta'$ , and finally four  $\Delta$ . This symmetrical arrangement of the observations appeared to be almost necessary, to avoid all influence of periodical changes in the mean of the results got by both stars. The reversion of the position circle was an object of high importance, as thereby all individual errors in the manner of producing the bisection by the micrometer-screw were destroyed. It must be mentioned here,

that in producing the bisection of the star by the wire, the last motion of the micrometer-screw was constantly given in the same positive sense.

"Before and after each set of four observations, as I have already stated, the zero-point was verified, to show that no change had happened in it. At first, a constant difference of about  $0''.15$  in the zero-point of the micrometer, when used in opposite positions of the screw, was ascertained. Afterwards I made the spring which regulates the motion of the micrometer-screw act a little more strongly, and from that time this little difference was quite destroyed.

"The total number of observations made for the determination of the parallax of *Groombridge 1830* was about 60. From this number all those were excluded in which, by a change in the state of the atmosphere, the complete number of comparisons with both stars in the fixed order was not obtained. Besides, the first two days' observations were also excluded, as for these the method of observation was not yet quite fixed, though they agree perfectly well with the results of the adjacent observations. After these exclusions there remain 47 complete observations; these observations are so distributed that 14 belong to a negative, 33 to a positive sign of the coefficient of the parallax in declination. The greater number of the observations made at a positive sign of the parallax depends solely on the more favourable state of the atmosphere in the spring, compared with that of the autumn.

Before I enter upon the results of my research, I wish to state that the foregoing detailed methods of observation were all fixed before beginning, or in the first two days of the observations. Besides, I can fairly declare that the observations were made, through all the time, without the least preoccupation with regard to the parallax. Until I had finished the whole series of observations, I had calculated nothing about the results, and I avoided even to think whether the maximum or the minimum of the parallax was to happen in the spring or in the autumn.

After having cleared the observed  $\Delta \delta$  of refraction, aberration, precession, and nutation, they were reduced to the mean epoch of my observations, 1848, Sept. 20. In this reduction I used the proper motion in declination =  $-5''.782$ , deduced by M. Peters from the comparison of his own observations with those made by Lalande, Groombridge, Bessel, and Nicolai. Then the equations of condition were formed and twice resolved by the method of least squares, with regard to the following two conditions:—

1. That the observed little differences in the sum of the two  $\Delta \delta$  were merely a consequence of the method of observing the first bisection on the place of the best bisection, and that the apparent irregularities in this sum could be attributed to accidental errors of observation.

2. That these differences were produced by little periodical changes in the direction of the tube, and consequently were pro-

portional to the intervals between the transits of each compared couple of stars.

"Both conditions could not be well united together in one system of equations, as I found some difficulty in separating exactly the qualities of their influence, especially as I had not indicated in my journal on what days I had observed the bisection produced by refraction or by direct motion of the tube.

"The resolution of both systems of equations, I. and II., gave the following results :—

$$\begin{array}{l} \text{I. } \left\{ \begin{array}{l} \text{The parallax of Groombridge 1830} = + 0''.005, \text{ with a probable error} = 0''.033 \\ \text{The proper motion in declination} = - 5''.768 \quad \quad \quad \text{,,} \quad \quad \quad = 0''.026 \end{array} \right. \\ \text{II. } \left\{ \begin{array}{l} \text{The parallax of Groombridge 1830} = + 0''.051, \text{ with a probable error} = 0''.028 \\ \text{The proper motion in declination} = - 5''.757 \quad \quad \quad \text{,,} \quad \quad \quad = 0''.023 \end{array} \right. \end{array}$$

"The probable error of the result for the difference in declination between *Groombridge* 1830 and the middle of the two compared stars obtained by one evening's observations was found to be  $= 0''.078$ . This number, however, corresponds only to the later period of my observations. In the first period the probable error for the result of one evening is about  $0''.12$ . According to this difference of the probable error in the resolution of the equations, the weight attributed to the observations of the first period was 0.4 of that belonging to the later period. It may be mentioned here that the use of different weights for the observations made in the different periods was of no consequence on the result for the parallax. The resolution of the equations I. and II., with the same weight for all observations, gave the parallax (I.)  $= + 0''.009$ , (II.)  $= + 0''.053$ , both values according with the preceding two results within  $0''.004$ .

"Neither one nor the other of the preceding two results can be regarded as quite exact, but the most exact value of the parallax following from my observations must lie between them both. However, I am inclined to give the preference to the second result, as by the method followed in the formation of the equations of condition a somewhat lower weight was attributed to the comparisons with the preceding star. This appears to be quite according with the nature of the observations, as, from the faintness of the star *b*, the observations of it in the full illuminated field were very difficult when the state of the atmosphere was not quite favourable; and if I was obliged, for this reason, to illuminate the field less, the bisection of the stars by the micrometer-wires was less accurate. This difficulty was never felt in the observations of the star *a*.

"The mean of the preceding two results for the parallax is  $+ 0''.028$ , with a probable error equal to that of each of the single results, or about  $0''.030$ . Hence it is evident that the parallax of *Groombridge* 1830 is so small, that the determination of its real numerical value is nearly out of the reach of the most perfect appliances of modern astronomy. If we do not adopt  $0''.028$  as an exact value of the parallax (the probable error being greater than the deduced

quantity), at least we can say that it is nearly certain that the real value of the parallax is considerably inferior to a tenth of a second. Therefore the parallax =  $+ 1''.08$ , determined by M. Faye, can only be attributed to an imperfection in the method of observation adopted by that distinguished astronomer. Also the value of the parallax =  $+ 0''.226$ , found by M. Peters, is certainly erroneous, but it approaches near to the reality, as he had indicated for this value a probable error of  $0''.141$ .

"The proper motion in declination of *Groombridge 1830*, determined by me and compared with that deduced by M. Peters from the absolute declination observed in the space of 53 years, is, I think, also a favourable proof of the quality of my observations. Both values accord within the limits of their probable errors; and the value determined by me, though only derived from two years' observations, is even superior to that of M. Peters with regard to the probable errors."

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*On the Computation of Ephemerides of the Moon.*

By Mr. S. M. Drach.

The object of the writer is to prepare a form of Lunar Tables, slightly different from any at present in use, of which the characteristics may be described as follows:—

In the symbolical theory of the moon, the moon's longitude for any arbitrary time is necessarily expressed by sines and cosines of simple multiples of the time; and this form is retained by Damoiseau in the construction of his Lunar Tables. But Bürg and Burckhardt conceived that the calculation of ephemerides might be facilitated by using, as arguments for some following inequalities, multiples of time corrected by some preceding inequalities. Mr. Drach proposes to extend this system by correcting the multiples of the time, not (as Bürg and Burckhardt have done) by applying to them the exact amount of the preceding inequalities, but by applying to them certain multiples of the preceding inequalities. And Mr. Drach proposes to effect the multiplication of the preceding inequalities by this artifice. Suppose the multiples of time to be expressed by one graduation of the circle (*e.g.* the centesimal), and suppose the first inequalities to be expressed by another graduation (*e.g.* the sexagesimal); then, if we add to the *centesimal* argument the *numerical* value of the sexagesimal inequalities, we are adding to the argument a quantity really smaller than the amount of those inequalities. If the multiples of time had been expressed by sexagesimal graduation, and the first inequalities by centesimal graduation, then the addition of the *numerical* value of those inequalities would increase the arguments by a quantity greater than the inequalities.

The success of such an artifice must depend entirely on the skill with which its details are worked out; and, therefore, nothing more can be done at present than to describe the general principle.

*An Account of some Improvements in a Speculum Grinding and Polishing Machine.* By John Hippisley, F.R.A.S.

“The machine, as far as regards the general action of two ex-centric pins, which transmit motion to the grinding and polishing tools, is similar in principle to that adopted by Lord Rosse, and other machines previously in use.

“The improvements consist in the arrangement of the parts so as to effect cheapness and facility in the construction, with general convenience in use, and *especially* in the manner in which the polishing tool is connected with the apparatus which gives it motion.

“This connexion is made by a ball and socket-joint of a novel construction,\* which, while it transmits a perfectly equable motion without jerks or irregularities to the polisher and leaves it free also to revolve about its own centre, as the friction between it and the speculum may direct, facilitates the application of counterpoise weights, so as to counterbalance in any required degree the weight of the polisher, especially in the very last period of the polishing.

“A polisher of considerable lightness has justly been deemed indispensable, and, for this purpose, wood has been used instead of metal in its construction. This material is, however, obviously liable to unsymmetrical alteration of figure, from unequal expansion and contraction by moisture and heat.

“Nor does it, it is submitted, adequately fulfil the condition required, namely, that of sufficiently removing pressure from the speculum. It appears almost demonstrable that the last finishing action of the polisher will be exerted with most advantage, to the perfection both of figure and polish, when it moves without any vertical pressure whatever. Those who are familiar with the adjustment of reflecting telescopes are aware that the slightest confinement or pressure on the speculum, when in its place in the telescope, is sufficient to impair its power of definition, in other words, to alter temporarily, in some degree, however small, its figure. A pressure, certainly far less than that which a wooden polisher will exert, is capable of producing this injurious effect.

“It is, then, to be expected, that when a speculum has been receiving its final figure under any pressure, that there will be some, however slight, recession from that figure when the pressure is removed; and, if so, the remedy obviously is to diminish *successively*, by counterpoises, the weight of the polisher as the figure and polish are advancing, till it ultimately moves, in giving the last finishing strokes, without any more pressure than the cohesion between the polished and sliding surfaces affords. It may also be expected that the lustre and perfection of the polish itself will be enhanced, inasmuch as the size of the abraded atoms will

\* A plan of the ball and socket-joint accompanied the memoir, which was further elucidated by a working model. Unfortunately Mr. Hippisley's stay in London was not long enough to allow the model to be sufficiently considered.

then be at their minimum, since they diminish in a direct ratio with the diminution of pressure by the abrading surface.

“In the machine to which these observations refer, the pulley which drives one excentric rod is made to differ slightly in diameter from its fellow, with which it is connected by the endless band, which gives motion to the other excentric rod; so that the centre of the polisher, by their joint action, is constrained to describe curves, varying from nearly a straight line to ellipsoids having a minor axis equal to twice the thrust of the shorter excentric; and the parabolic figure is attained by the maintenance of a certain proportion, found experimentally, between the throws of these two excentrics. This proportion, for a speculum having an aperture of one inch for each foot of focal length, and under the action of a polisher of the same dimensions as the speculum, is one-third of the diameter of the speculum for the longer, and one-seventh for the shorter thrust; the figure of the speculum receding towards a spherical figure if that shorter thrust be diminished, or advancing to the hyperbolic curvature if it be increased.

“The counterpoises, then, it is suggested, should be added successively, and at those periods in the action of the machine when it may be considered that its tendency to give a parabolic figure is at its maximum; that is, when, by the combined action of the excentric pins, the centre of the polisher is describing the widest ellipsoids on the speculum. A bent wire is so placed, as an index, on the excentric rod that its point, traversing a scale fixed in any convenient position, shows the exact moment when these widest ellipsoids are being described: at those intervals the counterpoise-weights are successively added, so that the polisher may be considered to pass through *complete* cycles of its action under each alteration and diminution of pressure.

“Attention to these conditions has, in specula finished by the machine, apparently been entirely successful, both in obtaining an exceeding fine polish, and a figure which does not sensibly deviate from the parabolic.

“A nice attention to the quantity and purity of the water used in the polishing is also of much importance. A very convenient method, which, being self-acting, requires no particular care during the process, is to fix a small vessel on the excentric rod, with a thread depending from it, and so adjusted that the single drop which by the capillary and syphon action passes from the thread shall, at the extreme thrust of the excentric rod, be deposited at the edge of the speculum. The quantity may be nicely regulated by the use of a smaller or larger thread; and the water is secure from containing any gritty particle, being filtered in its passage through the thread.

“The machine is of an easy and cheap construction, and intended to be worked by the foot acting on a treadle, or by any other convenient motive power: the same lever apparatus which is used for counterpoising the polisher in finishing, being connected by a vertical rigid bar with the ball and socket joint of the tool,

affords means for adding any required amount of pressure in the rough grinding process, and thus that tedious part of the operation is considerably accelerated. It is also adapted for figuring lenses of large dimensions, to which it would impart, as well as to specula, surfaces approaching nearly to those of parabolic, or other required geometric curvatures, and with the addition of another mandril, or more, receiving rapid motion from the periphery of the fly-wheel, it has been used with great convenience for grinding and polishing lenses of the smallest dimensions.

*On the Construction of a small Observatory, a new Stand for a Transit Instrument, and an Eye-piece for facilitating the Rectification of Instrumental Errors by Reflexion.\** By John Drew, F.R.A.S.

"A very excellent 5-foot telescope by Dollond, which had been tested by Captain W. H. Smyth, who mentions it with approbation in the *Celestial Cycle*, came into my possession some time since. To use this instrument with advantage I constructed a small observatory, which has answered the purpose so well that I beg to offer a plan of the building for the use of such members of the Astronomical Society as may wish to have a convenient lodgment for moderate sized instruments at a small expense. I have followed, in most respects, the description given by the Rev. W. R. Dawes of his observatory, in vol. vii. No. 10, of the *Monthly Notices*, the principal difference being in the walls, which are formed of  $\frac{3}{4}$ -inch weather boarding, the planks overlapping about  $1\frac{1}{2}$  inch; the roof only is covered with canvass outside the boards. The experience of two winters satisfies me that the structure is weather-proof.

"Before the foundation was laid, the ground was excavated to the depth of 18 inches and filled up with concrete; on this, brickwork is raised 6 inches above the ground. An oaken curb is laid on the brickwork, into which are inserted uprights  $2\frac{1}{2}$  inches by 2, and 6 feet in height. These are united at the top to a corresponding curb, and outside of these are nailed the boards forming the walls.

"The observatory consists of two compartments, the equatoreal-room and the transit-room; the former is 9 feet in diameter, in the form of a duodecagon; the roof is nearly circular, and similar to that of Capt. Smyth at Bedford, with shutters opening in the side, increasing from 9 inches to 2 feet 6 inches in width. The lower curb of the roof and the upper curb of the wall are fitted with cast-iron plates, between which are the 3-inch cannon-balls which support the roof and enable it to revolve. The telescope is mounted with a polar axis having the usual adjustments: the right ascension and declination circles are each 15 inches in diameter, and read off,

\* Drawings accompanied this paper, and a model of the transit and stand was presented at the same time by Mr. Drew.

the one to 4 seconds of time, the other to 1 minute of space. The shutters of the transit-room run along the ridge of a sloping roof, which is held together by iron hoops extending across the slit; these admit of being turned round so as not to interfere with distinct vision. The transit-room, which was originally occupied by a small astronomical circle, is 7 feet long by 6 wide. After I had built it, a very excellent 4-foot transit instrument, by Mr. Jones, late of Charing Cross, came into my possession, and a difficulty arose as to the manner of mounting it in so small a space. Some hints from the Rev. R. Sheepshanks enabled me to overcome the difficulty, and to construct a mounting which, while it occupies a small space, is so stable, symmetrical, and convenient, that I beg to present a model of it to the Society for future reference.

"On the concrete I laid a solid foundation of brickwork wrought with cement; embedded in this is a slab of Portland stone, 6 inches thick, 2 feet 4 four inches from north to south, 3 feet 6 inches from east to west. Two blocks are then erected on the east and west sides of this slab, 1 foot thick, and 2 feet 6 inches high; these have an open space of 1 foot 6 inches between them for the observer's legs. Another slab, of the same size and thickness as the first, is laid across these blocks. On the north and south sides of this upper slab two semicircular spaces are hollowed out, to admit of the observer's approach to the eye-piece of the transit instrument when the telescope points near the zenith. From the east and west sides of this upper slab rise the two piers, 1 foot square at the base, each of them bevelled off from the part immediately beneath the axis of the transit to a thickness of 6 inches; on these piers, which are 3 feet high, rest the plates which support the pivots of the axis of the transit instrument. The floor of the room runs over the first slab, and is independent of it; while the second slab, under which rest the legs of the observer when in a sitting posture, serves as a table for recording the observation.

"It is necessary with this mounting to make use of a diagonal eye-piece in taking transits of stars more than  $55^{\circ}$  in altitude; most of the slow-moving circumpolar stars may, however, be observed with a direct eye-piece.

"The upper slab affords facilities for correcting the adjustments by reflexion from a surface of mercury; for this purpose I use an eye-piece of a very cheap and simple construction, which enables me to arrive at the desired result with ease and precision. The wires of the transit instrument, when it is in a vertical position, are illuminated by a small mirror attached externally to the eye-piece, and moving on a hinge; by this mirror the light is thrown obliquely through an aperture in the side, and the wires illuminated; the direct and reflected images will then appear by looking down into the mercury through the telescope.

"The Beaufoy Clock, of which the Society has obligingly allowed me the use, stands on a pier in the transit-room.

"The cost of the observatory, exclusive of the instruments and their mounting, was 50*l*.

"The latitude and longitude of my station, as determined by triangulation from the Ordnance Map Office, Southampton, are as follows:—

Latitude .....	50° 54' 34" North.
Longitude .....	1 24 25' 8 West.

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Mr. Edward Cowper, professor of manufacturing art and engineering in King's College, University of London, presented a model with a description of an equatoreal mounting for a telescope. The peculiarity is in the polar axis. He proposes to make this a cast-iron pillar of great length and substance, resting with its lower end, which is continued a good way below the floor, in a socket, and having its upper support a little above the floor on a stone pier, through which the pillar is carried. The adjustments of the axis are made at this upper support, and above this there is a considerable length of axis quite clear.

A thimble or cap of a conical form goes over the polar axis, and is fitted to it at the top, and again a little above the floor. On the upper end of the cap the declination axis is fixed, just as in the German mounting. This cap carries the lower circle at its base, and is so long that there is comfortable room for the telescope and the head of the observer above the pier.

Mr. Cowper remarks, "that in this arrangement the telescope can pass the meridian in any position; the telescope can be directed to the pole without any impediment; the circles may be of large dimensions, and the polar axis being long, the motion is true. By treating the whole as a piece of *engineering* work, making everything as solid and strong as an engineer would do in making a crane to carry 20 tons or a 25-foot jib, the necessary stability would be easily attained."

Besides presenting a model, Mr. Cowper has sent a drawing with his description, so that there can be no difficulty in understanding the whole of the contrivance.

Mr. Dale presented the model of an instrument intended to be a substitute for the sliding rule.

This consists of one or more logarithmic spirals carefully drawn on a smooth plane, and a jointed rule resembling in form the usual sector in the case of mathematical instruments.

The fundamental property of the logarithmic spiral is, that all sectors having the same angle between the radii vectores are, in every respect, similar.

In Mr. Dale's drawing, the radius vector is supposed to increase tenfold in one revolution. The jointed rule is graduated on the inner edges to equal parts, reckoned from the centre; and the centre, on which the two parts of the rule turn, is fitted by a pin exactly upon the centre of the spiral.

To find a fourth proportional:—1st, Turn the rule round until that division of the scale on the first leg, which expresses the first term, is cut by the spiral; hold this in its place, and turn the other leg round the joint of the rule till it is also cut at the second term by the spiral. Now, carefully keeping the rule at this opening, turn the whole round till the third term on the first leg is cut by the spiral. The fourth or required term will be that division on the round leg which is cut by the spiral.

To find the square of any number, the first leg must be set to 1, and the second to the number whose square is required. If the rule be now turned through this angle, the second leg will show the square.

If a divided circle be drawn concentric with the spiral, then the square, cube,  $n$ th root may be found by placing the legs at one-half, one-third, one- $n$ th of the angular opening between 1 and the number whose root is required.

Also, by dividing other concentric circles so that the first leg remaining at 1 or 10, the other leg cuts the spiral at the value of various functions of the arcs, it is easy to introduce trigonometrical and other functions.

Mr. Dale shows how, by using a second spiral on a different scale, the same instrument may be made to apply to a greater extent.

If this instrument should be found useful, it would probably be necessary to adopt some contrivance for preserving the angle between the legs of the rule while the whole scale is turned about.

“The spiral may be laid off by drawing radii and marking off the lengths from a table of logarithms. It can, however, be described by continuous motion: for if a wheel have a female screw cut through its axis, and this be screwed upon a radius having on it a male screw, then, on turning round the radius, the track of the wheel is a logarithmic spiral.”

Mr. Rümker has sent a copy of all the observations of the moon and culminating stars which have been observed at Hamburg in the years 1848, 1849. These will be carefully preserved for reference and consultation.

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#### ERRATUM.

Vol. x., No. 2, p. 40, *for* Leary not mounted *read* Carey not inverted.



# ROYAL ASTRONOMICAL SOCIETY.

Vol. X.

February 8, 1850.

No. 4.

THE Annual General Meeting of the Society, G. B. AIRY, Esq.,  
Astronomer Royal, President, in the Chair.

The following gentlemen were proposed as Associates of the  
Society :—

Professor Benjamin Pierce, Dr. Baché, Professor O. M. Mitchell,  
and Sears C. Walker, Esq.,—all of the United States.

Richard Farley, Esq. First Assistant on the Nautical Almanac  
Establishment, and Henry Perigal, Jun. Esq. of Smith Street,  
Chelsea, were balloted for and duly elected Fellows of the Society.

## *Report of the Council to the Thirtieth Annual General Meeting.*

The Council have once more the pleasure of meeting their con-  
stituents with the information that the prosperity of the Society  
continues unabated, and that the progress of the science for the  
cultivation of which it was established continues unchecked.

The Report of the auditors, subjoined, will show the state of  
the finances :—

### RECEIPTS.

	£	s.	d.
Balance of last year's account .....	382	5	3
1 year's dividend on £ 900 Consols .....	26	4	4
$\frac{1}{2}$ ditto on £2317 6s. 11d. New $3\frac{1}{2}$ per Cents ...	36	11	2
$\frac{1}{2}$ ditto on £2363 12s. 6d. ditto .....	37	5	10
On account of arrears of contributions .....	68	5	0
82 contributions (1849-50) .....	172	4	0
6 ditto (1850-51) .....	12	12	0
7 compositions .....	147	0	0
33 admission fees. ....	69	6	0
27 first year's contributions .....	49	7	0
Sale of Memoirs, &c. ....	71	16	6
	<hr/>		
	£1072	17	1

### EXPENDITURE.

Cash paid for investment of 4 compositions.....	84	0	0
Mr. Barclay, for printing Memoirs .....	111	2	2
Ditto for printing Monthly Notices, &c.....	127	9	0
	<hr/>		
Carried forward.....	£322	11	2

## Report of the Council

EXPENDITURE (*continued*).

	£	s.	d.
<i>Brought forward</i> .....	£322	11	2
Mr. Basire, engraver .....	13	14	6
Mr. Wyon, medals .....	34	13	0
Taxes { Land tax and window duty, 4 quarters ...	8	5	2
Income and property tax, 4 quarters .....	1	9	2
	9	14	4
J. Williams, for 1 year's salary as Assistant-secretary .....	100	0	0
Ditto commission on collecting £443 10s. 6d.....	22	3	6
Charges on books, and carriage of parcels .....	3	0	5
Postage of letters and Monthly Notices .....	26	6	3
Porter's and charwoman's work ..	13	3	4
Tea, sugar, biscuits, &c. for evening meetings .....	13	13	0
Coals, candles, &c.....	12	18	6
Sundry disbursements by the Treasurer .....	20	4	8
Balance in the hands of the Treasurer (Jan. 1850).....	480	14	5
	£1072	17	1

The assets and present property of the Society are as follows :

	£	s.	d.
Balance in the hands of the Treasurer .....	480	14	5
1 contribution of 7 years' standing .....	£14	14	0
4 ——— of 6 ditto .....	50	8	0
1 ——— of 5 ditto .....	10	10	0
4 ——— of 4 ditto .....	33	12	0
3 ——— of 3 ditto .....	18	18	0
7 ——— of 2 ditto .....	29	8	0
18 ——— of 1 ditto .....	37	16	0
	195	6	0
Due for books, &c.....	14	17	0
£900 3 per Cent Consols.			
£2363 12s. 6d. New 3½ per Cent Annuities.			
Unsold Memoirs of the Society.			
Various astronomical instruments, books, prints, &c.			

The stock of volumes of the *Memoirs* still in the Society's possession is as follows:—

Vol.	Total.	Vol.	Total.	Vol.	Total.
I. Part 1	46	IV. Part 2	172	XI.	249
I. Part 2	91	V.	186	XII.	260
II. Part 1	108	VI.	204	XIII.	281
II. Part 2	74	VII.	229	XIV.	466
III. Part 1	135	VIII.	216	XV.	255
III. Part 2	155	IX.	224	XVI.	289
IV. Part 1	158	X.	238	XVII.	298

The progress and present state of the Society, with respect to Fellows and Associates, is as follows :—

	Compounders.	Annual Contributors.	Non-residents.	Patrons, and Honorary.	Total Fellows.	Associates.	Grand Total.
February 1849 .....	124	130	71	6	331	57	388
Since elected .....	3	29	...	...	32	...	32
Deceased .....	— 5	— 2	— 1	...	— 8	...	— 8
Resigned .....	...	...	...	...	...	...	...
February 1850 .....	122	157	70	6	355	57	412

The instruments belonging to the Society are now distributed as follows :—

The *Harrison* clock,  
 The *Owen* portable circle,  
 The *Owen* portable quadruple sextant,  
 The *Beaufoy* circle,  
 The *Beaufoy* transit,  
 The *Lee* circle,  
 The *Herschelian* 7-foot reflector,  
 The *Greig* universal instrument,  
 The *Smeaton* equatoreal,  
 The *Cavendish* apparatus,  
 The Universal quadrant by Abraham Sharp,  
 The 7-foot Gregorian reflecting telescope (late Mr. Shearman's),

are in the apartments of the Society.

The Brass quadrant, said to have been *Lacaille's*,  
 is in the apartments of the Royal Society.

The Standard scale

is in the charge of the Astronomer Royal, with the consent of the Council, to be employed in the formation of a new Standard Measure, under the direction of the Standard Committee.

The remaining instruments are lent, during the pleasure of the Council, to the several parties undermentioned, viz. :

The *Fuller* theodolite, to the Lords of the Admiralty.  
 The *Beaufoy* clock,  
 The two invariable pendulums, } to the Royal Society.  
 The *Wollaston* telescope, to Professor Schumacher.  
 The *Variation* transit (late Mr. Shearman's), to Mr. J. Rees.  
 The other *Beaufoy* clock, to Mr. J. Drew.

The Council observe with satisfaction the steady growth of the Society in numbers, a proof of increasing interest in the science of astronomy. And this satisfaction is augmented by the reflection that a very large proportion of the newly-elected Fellows are persons who are actually engaged in the cultivation of some branch of the science.

The Council call the attention of the Society to the manner in which they have felt it their duty to propose to increase the list of Associates, by the addition of names from the United States. The very great impulse given to astronomy in that part of the world within the last few years will ultimately demand many acknowledgments of the same kind.

Since the last meeting, the publication of the seventeenth volume of the *Memoirs* has been made, containing the papers read in the Session 1847-48. The volume of *Monthly Notices* corresponding has also been published, as well as that which follows, the latter being vol. ix. of the series. The eighteenth volume of the *Memoirs* is printed within a sheet. The plan which connects the volumes of *Memoirs* and those of *Monthly Notices* (that they are supplementary to each other) is now, the Council hope, well understood by all the Fellows; but it may be useful to allude to it.

It will be observed that the Annual Reports, which are given at length in the *Monthly Notices*, are reprinted in the *Memoirs*. This has always been done; but it will strike every one that there is an apparent superfluity and needless expense in continuing the practice, now that the two volumes are made to form one publication, and each is considered as necessary to the other. The Council are desirous the meeting should know that this point has not escaped their attention, and that the continuance of the old practice has been a result of deliberation. Among the reasons which have guided them is one which has been strongly urged, and which is of force, so long as the funds will admit of the outlay without detriment to the wants of the astronomy of the day. It is well known that publications of different sizes, as quarto and octavo, are with difficulty kept together for centuries: and that, as years go by, there is much reason to suppose the *Memoirs* and the *Monthly Notices* will be found separate from each other. It is also well known that the demand for any set of transactions, when ancient, is very much augmented by their containing historical information; and abundance of instances might be given in which books are now sought for on that account, in preference to others of more intrinsic value. Until these reasons have received the fullest scrutiny, the Council have thought it best to continue the printing of the Annual Reports in the *Memoirs*, satisfied that, by so doing, they are increasing the permanent value of that series to an extent which will fully justify them, until such time as the money thus expended is imperatively required for some purpose of still greater utility.

The *Monthly Notices* in their extended form have now been a considerable time before the Society, and appear to have been

favourably received. There is, however, one considerable drawback ; the expense of printing and forwarding the *Notices* is very large, larger perhaps than is quite consistent with extreme prudence. Still the advantages are so considerable that the Council does not recommend any change at present. All superfluity of language will be retrenched, without altering or obscuring the views of the contributor, and every essential preserved. The members will have remarked with pleasure the admirable lectures delivered by the President, which he has himself kindly prepared for the press. Although this additional labour has at times been exceedingly inconvenient to him, he has felt the justice of the remark that a report by any other person would be imperfect and faulty, and he has submitted to a very irksome task for the general good and the especial credit of the Society.

The Council cannot pass over without an expression of satisfaction the frequent arrival of presents of a highly interesting and useful class ; they refer to models of instruments and contrivances, which are very often not only the proof of successful thought, but the instigation of it in others. At a time when all that was once held most sacred and venerable in the forms of instruments is undergoing unusual scrutiny, and new propositions of a singular character are emanating from authorities high in the estimation of all, it is clear that the field is peculiarly open to every inquirer, and also that the number of such inquirers is much augmented. To the Astronomer Royal, therefore, for various presents of models constructed by himself, in illustration of his addresses at our meetings, and particularly for one of the prime vertical transit lately erected at Pulkowa ; to Mr. Nasmyth, for a model of azimuth and altitude mounting of a reflecting telescope ; and to Mr. Cowper, for an equatoreal mounting of the same instrument, the thanks of the Council are most justly due. It is not the least important feature of these useful presents, that they are lessons in the construction of such illustrations at a cost much below that which was once thought requisite : time was when it was supposed that nothing of the kind was worthy of being offered to a society, unless it were highly finished in metal. The Council need hardly say, that the results of valuable contrivance in plain wood are as acceptable as those of thought or research in homely handwriting ; neither polished metal nor calligraphy are necessary to make such offerings useful to astronomers.

The Council have commenced the printing of a new Library Catalogue, several sheets of which have been struck off. It has been compiled by the Assistant Secretary ; and the Council have to acknowledge with gratitude the offer of Mr. Woolgar to make the final examination and superintend the printing. Such a catalogue has been much wanted for some years past, not only on account of the large accessions which the library has received from the friends of the Society, but still more that the Fellows may have the means of knowing the books which were added at the time when the *Mathematical Society* was incorporated with ours. Of

our own books we may say that they are mostly such as we should be thought likely to have; so that those who want them would naturally inquire for them here. But in the incorporated library there is a large stock of the books which might aid an inquirer in other subjects besides astronomy, but of which he would hardly suppose we were possessed unless a printed catalogue, such as he could consult at home, should suggest to him where to find them. The catalogue will give the titles with sufficient fulness to identify the works, and will aim at such an amount of cross reference, and, in some important cases, of description of contents, as, without unduly increasing the expense, will add much to its utility.

At the close of the Report for last year, the Council alluded to the unsatisfactory position of our respected and venerable Associate, Professor Schumacher, and mentioned their application to Lord Palmerston for his interposition and good services. His lordship, with a readiness which entitles him to our warmest thanks, immediately represented the case to the Danish government, and received the most positive assurances that the Professor would be preserved from all injury, and left in peace to continue his valuable labours. Unfortunately the disputes between Denmark and the Duchies are still unsettled; and so long as this unhappy state continues, we fear the Professor's condition, respected though he is by all parties, must be unsettled too. We gladly state that the scientific representatives of almost every civilised state have cordially bestirred themselves in Professor Schumacher's favour—a gratifying proof of the honour in which he is universally held, and a testimony to the admitted importance of his long and useful labours. We are, moreover, rejoiced to find that his own peculiar troubles have had no benumbing effect on his intellectual exertions. The *Astronomische Nachrichten* is continued with the same talent and regularity as heretofore (even a supplementary part has been published in the last year), and the observatory of Altona is in full activity. Let us hope that, in the general return to order, the complicated affairs of Schleswig-Holstein may receive an early and satisfactory solution.

The Council have awarded the gold medal to M. Otto Struve, the son of our illustrious Associate, and himself an Associate, for his researches on precession, and on the effect of the motion of the solar system upon it. The President will, as usual, state the grounds of this decision. Astronomy is, more than any other, a science in which the hereditary tendency is frequent, and in the present instance it is very strongly developed. The Council cannot omit to acknowledge their obligation to Mr. Main, who drew up for their guidance a most elaborate and lucid report on the state of the question, and on M. Otto Struve's researches upon it.

The Council have to regret the loss, by death, of Major SHAD-

WELL CLERKE, Major LYSAGHT, Major WILCOX,\* Rear-Admiral Sir S. J. B. PECHELL, LEWIS HAYES PETIT, and BARTHOLOMEW BIDDER, Esqrs.

Major THOMAS HENRY SHADWELL CLERKE was born at Bandon, in Ireland, and educated at the Royal Military College of Marlow, where his diligence and conduct gained him the distinction among his young associates of being a cadet officer. Having entered the army, he was appointed to an ensigncy in the 28th Regiment of foot, on the 30th of July, 1805, and was made a lieutenant in the 5th Regiment in 1807. He served with acknowledged credit and gallantry during the first years of the Peninsular campaigns, having been present at the general actions of Roleia, Vimiera, Corunna, and Busaco; and at the combats of Almeida, the Coa, Pombal, and Redinha, at the last-mentioned of which affairs, on the 12th of March, 1811, he lost his right leg. Having become, on the conclusion of the war, a captain of the Staff Depôt, he was promoted to a majority in 1830, and was placed upon half-pay in June 1833.

Major Clerke was highly esteemed as an accomplished and very useful officer, and well known as the originator and able editor of that successful periodical the *United Service Journal*. This work he conducted from its commencement, in January 1829, till the month of June 1842, during which time he zealously seconded every undertaking for the advancement of professional knowledge among naval and military officers. In carrying out this object, he also lent his aid towards the establishment of the United Service Institution. He was, moreover, a Fellow of the Royal, the Geological, and the Royal Astronomical Societies, and at his demise had become Foreign Secretary to the Royal Geographical Society—an office for which his acquaintance with several of the modern languages well adapted him.

Major Clerke expired on the 19th of last April, under an attack of paralysis, at his residence in Brompton Grove, deeply regretted by a numerous circle of friends and acquaintance for his excellent social qualities and integrity of character.

Major THOMAS LYSAGHT was an officer of very considerable merit and acquirements, of the Honourable East India Company's forces. He entered the Bengal army on the 3d of June, 1820, as ensign in the left wing of the 1st European Fusileers, was made a lieutenant in 1823, a captain in 1837, and a brevet-major in 1846. During this time, his knowledge of military details and his practical facility in the Oriental languages strongly recommended him for special employment, and he was permitted to enter the Nizam's service in 1841. Here, in a sphere of great usefulness, he was attacked by an insidious disease, and died at Hingolee on the 29th of last June.

\* The Council are obliged to defer till next year some account of the life of Major Wilcox.

Rear-Admiral Sir SAMUEL JOHN BROOKE PECELL, Bart., was an officer of distinguished merit, and his attention to naval gunnery is evinced by his publications, especially that entitled *Observations upon the Fitting of Guns on board his Majesty's Ships*, of which three editions were circulated.

Sir Samuel was born in 1785, and was sent to sea at the early age of eleven years, under the protection of his maternal uncle the late Admiral Sir John Borlase Warren. During his novitiate, and while he served as lieutenant, he saw much active service, and assisted at the capture of an 80-gun ship (*Marengo*), three French frigates (*La Néréide*, *La Belle Poule*, and *l'Africaine*), one large corvette, and several stout privateers. He was made a commander in 1807, and posted into the *Cleopatra* of 36 guns. In this ship he displayed great gallantry on the 23d of January, 1809, in an action with a French frigate of the largest class (*La Topaze*), which had anchored under the protection of a battery at Guadaloupe, and was completely silenced before the *Cleopatra's* consorts arrived. The commander-in-chief was so pleased with the exploit, that he offered Captain Pechell the command of the prize, as a token of his approbation, saying to him at the same time, "As you have won her, you shall wear her." He further distinguished himself at the capture of Martinique, and on the shores of the United States, and served till the general peace in 1814. He afterwards commanded the *Sybille*, of 38 guns, on the Mediterranean station, where he was actively employed in the suppression of piracy among the Greek islands.

Sir Samuel Pechell was nominated a Companion of the Bath in 1815, and a Knight Commander of Hanover in 1833. He sat in Parliament for Helstone in 1830, and for Windsor in 1833, and was twice a Lord of the Admiralty. He died, after a lingering illness, on the 3d of last November, at his residence in Hill Street, Berkeley Square, in the 65th year of his age.

Of Mr. L. H. PETIT and Mr. B. BIDDER the Council have received no information. The former was known as an amateur lover of astronomy, and at one time a constructor of telescopes, and as a man of much information. The latter was Actuary of the Royal Exchange Life Assurance Company, and was attached to science in general, and a cultivator of mathematics.

JOHN GOLDINGHAM, Esq. is known to science by his long occupation of the post of Astronomer at Madras. He died at Worcester, at an advanced age, a few days before the last annual meeting of this Society. But it is not so generally known that he held a public post as a civil engineer in India during the early part of his tenure of the observatory. The banqueting-room at Madras, a building universally admired, was erected by him in 1800. As astronomer, he published two volumes of observations: one of them, published in 1827, contains his observations of the length of the pendulum, of the velocity of sound, of meteorological pheno-

mena, as well as determinations of the longitude of Madras, and a discussion of the longitudes of the three Presidencies. Some of these papers had been previously printed in the *Philosophical Transactions*. It does not appear that Mr. Goldingham was much in communication with European astronomers during the active part of his Indian life; and to the want of concert among astronomers of that time, and also to the absence of such a point of union then as is now afforded by our Society, it is perhaps to be attributed that no continuous astronomical effort, no regular series of observations, appears to have been made by him.

The construction of the large transit circle for the Royal Observatory of Greenwich has been steadily, though slowly, advancing. The only part of the work hitherto effected to which it appears necessary to invite the notice of the Society, is the method of turning the pivots. It has already been stated to the Society that the instrument is made of cast-iron, its pivots being cast in the same flow of metal with the conical transit-axis; and that the surface of these pivots is made nearly as hard as hardened steel by the process technically called *chilling*, that is, casting in a mould of warmed iron. It would have been impracticable to turn these by the point of any tool except a diamond. Mr. May, however, has arranged a method of turning which may roughly be described as follows. The axis (where the iron is soft) having been very carefully bored, and a long bar having been very nicely fitted to it, this bar is made to carry an apparatus, of which the efficient part is a copper wheel, whose edge is presented to the external surface of the pivot; this copper wheel is charged with emery powder, and is made to revolve very rapidly, and thus the surface of the pivot is cut away. At the same time, the bar which carries that apparatus is made by other machinery to slide slowly up and down the axis, and to rotate slowly; thus presenting the acting edge of the copper wheel in succession to every part of the pivot surface, and giving it a form not only circular but cylindrical also. The figure of the pivots thus turned has been tested, and appears to be perfect. The Council have reason to hope that Mr. May will, at the completion of this work, present the Society with an accurate description of a method which they cannot but regard as highly important in the present tendency of astronomical instruments to become larger and larger, while the requirements of accuracy in the mechanical movements are in nowise diminished.

Although a locality has been provided for the intended reflex zenith telescope at the Royal Observatory, no active step has yet been taken in its construction. The Astronomer Royal proposes to wait for an opportunity of trying the 10-foot object-glass of the existing transit-instrument (which can be obtained only after mounting the transit-circle) before determining finally whether that object-glass, or one of larger aperture, should be used for the reflex zenith telescope.

At Cambridge the observations have been chiefly directed to the determination of positions of the recently discovered planets, and of the places of stars used for reference in equatoreal observations. From press of business, Professor Challis has been compelled to desist from carrying on the equatoreal observations of the new planets on the same scale as in the two preceding years, and this is the less necessary, as the excellent observations of Liverpool, Markree, and Hamburg, form a full and pretty continuous history of these bodies. It is understood, that when Mr. Hartnup finds an object become so faint as not to admit of accurate observation, he will give notice to the Professor, who will then bring his more powerful telescope into action. Meanwhile Professor Challis has thought it advisable to substitute for them, in part, a class of observations of a simpler character, the utility of which cannot be questioned. As the new planets generally occupy positions within a few degrees of either side of the ecliptic, the exact places of the stars in this region of the heavens become important as points of reference in the equatoreal observations of these bodies. Professor Challis has accordingly commenced a series of meridian observations of stars, to the ninth magnitude inclusive, situated in a zone extending from  $5^{\circ}$  above to  $5^{\circ}$  below the ecliptic. The observations were at first made by the mural circle used as a transit circle, but latterly both transit and mural circle have been employed to obtain places as exact as possible.

The volume of Observations of 1843 was published in the latter half of 1848; that for 1844 was published during the last year; and the printing of that for 1845 is now commenced. Some changes in the arrangement of the University lectures will leave additional time at Professor Challis's disposal for the reduction of the arrears of printing. As one means towards this end, he has thought it expedient to make an alteration in the printing of the transit observations, by which the transit as observed, and the leading steps of the calculation, are contained in one page, instead of extending over opposite pages as formerly. The alteration has been made on the principle of retaining all that is recorded in taking the observation, and omitting only some results in the course of the reduction, leaving the same opportunity of verifying the accuracy of the final result as before. A similar plan has been fixed upon for abbreviating the printing of the circle observations. The effect of these alterations will be to allow of putting the meridian observations of two or even three years into one volume, and thus obviate the necessity of repeating the introduction for each year. The time and expense of passing them through the press will consequently be diminished, and the value of the published observations will be in no material respect reduced.

The instruments continue in a satisfactory state.

The principal occurrence to report from the Radcliffe Observatory at Oxford is the erection of the heliometer.

The arrival of the instrument was mentioned in last year's Report, and the building for its reception was begun in the month of March last: by the beginning of October it was sufficiently advanced to allow of the instrument being placed on its pier, which was done under the immediate personal superintendence and direction of Mr. A. Repsold.

The instrument was packed in eleven large cases, which had to pass through a variety of conveyances in the long journey from Hamburg to Oxford. Notwithstanding this, such had been the care in packing it, that not the slightest injury was detected in any part.

This is not the place to enter into a detailed description of the instrument or of the observatory. Such a description, accompanied by illustrative drawings, will probably appear in due time. Here it will be sufficient to mention that the diameter of the divided object-glass is  $7\frac{1}{2}$  inches in diameter, with a focal length of 10 feet 4 inches, carried by an equatoreal mounting designed by MM. Repsold themselves. This mounting was applied for the first time to an instrument sent to Christiana, in Norway, some years ago. In its general principle it is the same as Fraunhofer's, but differs in having the hour-circle at the upper end of the polar axis instead of the lower end. This arrangement admits of an hour-circle of large dimensions. In the Radcliffe heliometer the hour-circle is  $2\frac{1}{2}$  feet in diameter. The declination-circle is of the same size.

As a Heliometer the instrument presents some peculiarities of construction. Among these, the movement of the segments into which the object-glass is divided deserves the first mention.

In the instruments hitherto constructed the segments have been made to move in a straight line; consequently, when they are separated, they present images unequally distant from the observer's eye, and when the separation is great there is indistinctness of one image. This inconvenience was partially obviated by giving a circular motion to the eye-piece.

Bessel felt this defect long ago, and suggested to Fraunhofer the practicability of removing it; though it appears that the means of doing so did not occur to that distinguished artist. When the Radcliffe heliometer was ordered, Bessel again called the attention of MM. Repsold to the subject, and with better success. These skilful artists, by a device not less simple than ingenious, have made the segments move in the arc of a circle, the radius of which is their focal length.

In an historical point of view, we may be excused mentioning that they had been anticipated in this contrivance as long ago as 1767 by M. De Charnières, an officer of the French navy, distinguished as being among the first of those who applied themselves to the practical solution of the problem of finding the longitude at sea by lunar distances. For measuring distances, not exceeding  $5^{\circ}\frac{1}{2}$ , De Charnières constructed an instrument which he called a "Mégamètre;" this is, to all intent and purpose, the type (on a small scale, of course) of the modern heliometer. De Charnières

instrument was not quite unnoticed at the time, as we may gather from the fact of its having been used in marine surveying, and favourably mentioned by Captain Phipps (the first Lord Mulgrave) in his voyage towards the North Pole in 1773. It is described by its inventor in a work, *Théorie et Pratique des Longitudes en Mer*, Paris, 1772. In it we find the circular motion given on the same principle as by the Repsolds, though De Charnières' construction was not known to these distinguished artists.

The next peculiarity is the place of the Position Circle, which, instead of being close to the object-glass, is two-thirds down the length of the tube. By this arrangement it is accessible to the observer in all positions of the telescope.

The last, and a capital peculiarity, is the Scale for measuring the distances, and the mode of reading it off. In the Königsberg heliometer, it will be remembered that the measures were read off from micrometers *at the object-end* of the telescope, so that after every observation that end must be lowered, or the observer must climb up to it. This involved much loss of time and some risk of deranging the relative positions of the segments; to avoid this, MM. Repsold have applied an *interior* scale, illuminated by a galvanic stream acting on a platinum wire, and read off by long micrometer microscopes, the eye-pieces of which are adjacent to the observer's eye, so that he may make and read off his measures without leaving his chair. This, we believe, is the first application of galvanic light to an astronomical instrument, and is perfectly successful.

The object-glass is by Merz of Munich. The division of the glass impairs its power as a *seeing* telescope, for in no position of the segments is it practicable to obtain strictly a single image. But as a *measuring* telescope,—the light in which it should be considered,—it is all that can be desired. When the segments are separated, both images are clear and round, and those rays of false light at right-angles to the line of section, which Bessel observed in the Königsberg instrument, are seldom to be seen here. The present experience of the instrument is very favourable, but on this point it will be needless to enlarge, as the Society will, in all probability, soon have the means of judging of it by some of the results obtained.

At a time when it is not unusual to hear complaints of the apathy shown to the concerns of science, it is but justice to state that this instrument is an *unsolicited* offering of the Radcliffe Trustees to the astronomical appliances of our country.

The routine operations of the Radcliffe Observatory during the past year have been confined chiefly to the completion of the *Circumpolar Catalogue*. Very few stars in Groombridge's *Catalogue* are now left unobserved, and in the course of the present year this work may probably be brought to a close. But when this is done, and the current reductions completed, as they are annually, the labour of *arranging* the work of eleven years into a catalogue reduced to one *epoch* will be considerable—more than, with his present force, the

Radcliffe Observer can hope to get over in a short time, even if his attention were not distracted, as it is likely to be, by the heliometer. As the catalogue is of the greatest interest to astronomers, and as it is always desirable that such works should be published as soon as possible after completion, we feel assured that the Radcliffe Trustees will afford the necessary assistance for attaining this end, when its great utility, as one of the permanent landmarks in Astronomy, is pointed out.

It would be premature to speak of the future course of this establishment. Those subjects of observation to which the heliometer is more strictly applicable will naturally occupy a large share of its attention, and among them the important question of the parallax of the fixed stars will take a foremost place. Such inquiries will occupy more time than is expressed in the visible results, and are alone sufficient to employ the present personal force of the establishment. Nevertheless, we cannot refrain from expressing our hope that meridian observations on more than a small scale will continue to be carried on. We say, "on more than a small scale," because *some* meridian observations must continue to be made; those, for instance, for determining the absolute places of zero stars used in observations with the heliometer, those for the determination of time, &c.

The planets and brighter stars, even to the sixth magnitude, have been, or are in course of being, pretty well examined; but of the smaller stars, such as those in Lalande's or Weisse's *Catalogues*, the stars in the remaining zones of Bessel, Argelander, and Lamont, we know little beyond their places given in those collections. In the present state of astronomy, it would seem that a revision of such stars would be a work of considerable interest and importance. Of course, an undertaking of such labour can only be accomplished slowly and gradually, and as such is well suited to the powers of the Radcliffe Observatory. The question for consideration is not the building of a *new* observatory, but the maintaining and completing an *old* one, which is admirably equipped with instruments, and requires very little additional personal assistance to double its effectiveness.

We have not had any very recent intelligence from the Cape of Good Hope, but we understand the astronomical observations are proceeding with great activity now that the staff of the observatory are freed from their heavy task of measuring an arc of the meridian. Though we are justly proud of the energy and skill with which, under no common difficulties, this harassing operation has been carried out by Mr. Maclear, we have to regret that the effect upon his health has been exceedingly injurious, and that the fatigue and anxiety attending his exposure and responsibility have brought upon him the signs, and we fear some consequences, of premature age.

To the ninth volume of the *Monthly Notices*, Mr. Maclear has contributed a most accurate catalogue of southern stars, suspected by Professor Mädler to have large proper motion; and also a

singularly full and complete series of observations of Wilmot's Comet. Another series, equally full and complete, of observations of the interesting double comet of Biela, will be found in the first number of the volume in progress. It is necessary to examine these memoirs closely to become aware of the enormous quantity of labour which they so neatly represent. Our anxiety, with respect to Mr. Maclear, is only as to his health; if this be satisfactory, we feel assured of his astronomical activity and capacity.

An equatoreal by Merz and Son of Munich, precisely similar, we believe, to that possessed by Mr. Dawes, has recently been forwarded by the Government to the Cape Observatory, and has arrived *safely*. This is not an unnecessary announcement, for the package had been opened at the English custom-house, and the screws were not replaced in repacking it.\* Mr. Maclear has already applied this instrument to some of the more interesting double stars, and communicated the general result to Sir John Herschel. Thus the binary nature of  $\gamma$  *Coronæ Australis* is confirmed,  $\gamma$  *Antares* is seen as a double star admitting of measurement,  $\alpha$  *Centauri* goes on steadily in its orbit, and  $p$  *Eridani* has advanced  $30^{\circ} 35'$  since Sir John's measures.

Since the last Anniversary, the first of the annual visitations of the Edinburgh Observatory has taken place, and the Report presented by the Astronomer on that occasion, and approved by the Visitors, having been printed and extensively circulated, need not be specially alluded to here. As to subsequent matters, we may mention that another volume of Observations has appeared—the eighth, or that for 1842; and another, that for 1843, has been completed for some time in manuscript, and the printing is so far advanced, that it will probably be finished in a few weeks. The computations for 1844 have been commenced, and that being the last year of the arrears of observations, Professor Piazzi Smyth has inserted in the ninth volume a programme of his own intended course of observation, and the reasons upon which it is founded. These are essentially the same as those contained in a paper read before the Royal Society of Edinburgh in 1847, and alluded to in our Annual Report for the same year. Both the mural circle and the transit instrument are now in complete working order. Observations have been commenced with them, and the reductions are carried on, as far as possible, simultaneously with them.

The history of the Liverpool Observatory will be found in the volumes of the *Monthly Notices*, and the observations of the minor planets are the most satisfactory proofs of its power and efficiency. Any one acquainted with practical astronomy will see at once that

\* The necessity of unpacking the instrument at all is not very obvious. There are surely no duties to be paid in London when London is merely a port of transit. At any rate the carelessness which endangered a manifestly valuable and delicate instrument was quite inexcusable, and that it was destined for a government institution does not diminish the culpability.

such observations would do credit to any observatory and any instrument. The labour must not be estimated by the *space* which these observations occupy, a single line may compress the bodily toil of a night and the computation of a day. To estimate this properly a person should see the observations made, and go over the reductions. It must, too, be remembered that the astronomical observations published in the *Monthly Notices* are merely the by-work of the Liverpool astronomer. His special duty is to time and rate chronometers for the port of Liverpool, a duty which is performed with the most scrupulous accuracy, and we trust with increasing advantage to navigation.

Mr. Hartnup has undertaken to assist Professor Bond in determining the difference of longitude between Boston and Liverpool by chronometer; and several passages between the two ports have been made in the course of the year.

Those who have read the account of the longitude of Valentia by the President will acknowledge that the English end of the arc could not be in better or more experienced hands than Mr. Hartnup's.

In the course of last year a volume has been published, containing "*Results of Astronomical Observations made at the Observatory of the University, Durham, from January 1846 to July 1848, under the direction of Professor the Rev. Temple Chevallier, F.R.A.S., by the Rev. R. A. Thompson.*" These consist of observations of 298 stars; of a considerable series of the right ascensions of the moon's limbs, with the corresponding moon-culminating stars; of observations of the right ascension and north polar distance of the sun, moon, and planets; eclipses of *Jupiter's* satellites, diameters of the planets, &c. A few of the planetary observations, with the current reductions, have been published from time to time in the *Monthly Notices*; but in the published volume the whole series is given, with the necessary means of verification. There is a full account in the preface of the processes of observing and computing; and the work, which is very neatly and compactly got up, does great credit to the university from which it originates.

From the Madras Observatory we have accounts of active operations under Capt. W. S. Jacob. In the meridian department he is occupied in revising and perfecting the late Mr. Taylor's extensive catalogues of stars. He has likewise selected from the British Association Catalogue all those stars between the limits of  $40^{\circ}$  and  $155^{\circ}$  N.P.D. which depend upon only one observer: these are about 1200 in number. *Neptune* he has been observing, and would have observed the other new planets also, but that they are, unfortunately, not within range of the very small object-glasses with which his meridian instruments are furnished. Double stars, especially southern ones, will form a distinctive part of the duties of the *establishment*; and the Hon. East India Company have, we believe,

with this view lately provided the Observatory with an equatoreal of superior optical power. The instrument had not arrived at the date of the last advices; but when it does, we may look for interesting and important results from so able and zealous a double-star observer as Capt. Jacob has long since proved himself to be, as well as from the comparatively new field in which he will have to work. Pending the arrival of the telescope, he has been employing himself on the orbits of several double stars, and especially on that of *α Centauri*, which he has made peculiarly his own; and as the only other published approximation to an orbit gives 1867 as the date of the peri-astræ of the two stars, while he states 1853 as the time of the periastral passage, he has examined the limits of possible error of each of the elements of his orbit, and finds them so very small, as to induce him to look upon it as a well-determined stellar orbit; while, being the closest to us of any, and being seen under the greatest angular dimensions, it merits the closest attention from both observers and computers.

Among other striking proofs of the onward march of science in the western world, the foundation and progress of the Smithsonian Institution deserves particular attention. John Smithson, Esq., of England, left his property in trust to the United States of America, to found at Washington an institution which should bear his own name, and have for its objects "the *increase* and *diffusion* of knowledge among men." This honourable trust was accepted; and an act of Congress, passed August 10, 1846, appointed as trustees and governors the highest official members of the administration, and citizens distinguished for their talents and acquirements.

The institution will consist of a most extensive library and museum, with a gallery of art, lecture-rooms, &c. These are now in progress, and it is expected that after the completion of the buildings there will be left an annual fund of about 40,000 dollars for the purposes of the Society.

It is intended to publish every year a quarto volume of original researches, historical, scientific, &c., in which astronomy and its related sciences promise to bear a conspicuous part. We have already been favoured with a memoir\* extracted from the second volume, containing an elaborate inquiry into the elements of *Neptune*, with a very accurate and extended ephemeris of the planet, by Mr. S. C. Walker: several more astronomical papers will be inserted in the volume.

To carry into effect Mr. Smithson's second object, the "*diffusion* of knowledge," the regents of the institution have offered most valuable assistance in facilitating the interchange of transactions and scientific memoirs between the United States and other countries: in no way could the design of the founder be more legitimately and usefully fulfilled.

\* Copies of this memoir have been very liberally distributed in this country through the Royal Astronomical Society.

The astronomical expedition sent by the Government of the United States to the coast of Chili, for the purpose of making series of observations on *Mars* and *Venus*, simultaneously with other observations in distant situations, has been already mentioned in the *Monthly Notices*. The difference between the simultaneous determinations will give the parallaxes of the two planets at times when these greatly exceed the parallax of the sun, and from such data it is hoped that the parallax of the sun may be deduced with great accuracy. The instruments for this expedition have been chiefly provided by a government appropriation, but the Smithsonian Institution has lent a valuable achromatic telescope, which has been constructed by an American artist for this special service. Lieut. Gilliss, who commands the expedition, has had great experience in the use of astronomical instruments, and will, undoubtedly, apply himself zealously to his task. The time when the planets are unfavourably situated for the determination of parallax will be devoted by Lieut. Gilliss to other astronomical researches. A very careful programme of the intended series of observations has been published by authority, and numerous copies sent to this and to other countries with a request for co-operation.

The observations for restoring the Standard Yard have been progressing slowly, but on the whole more satisfactorily than in former years. Many of the difficulties have been overcome and others have been palliated. Still the definition of the lost yard, or the construction of *exceedingly* accurate copies, are not by any means very simple problems or such as admit of rapid solution. The observations are made on which the new yard will be based; and though there is a good deal of small computation and correction yet to be done, much is already done, and no difficulty is foreseen. When the Committee have decided upon the relation of a certain measure, set off upon a new bar, to the lost standard, the multiplication of copies will be neither very tedious nor difficult. The apparatus is convenient and manageable. The only points in which improvement seems to be required, is in the finish of the divisions and the mode of illuminating them. Perhaps the microscopes admit of some change for the better in their optical part; but as matters are now, there is, it is believed, no doubt as to the great superiority of the measuring apparatus at present employed above anything of a similar nature used previously.

This is, perhaps, a proper occasion on which to invite the assistance of all gentlemen who are accustomed to make exact metro-metrical measures. The present observer is not able to make many continuous observations, from weakness of eye, neither are the single bisections quite so good as they might be and ought to be. But besides this, it is known by actual experiment, that different persons disagree, and sometimes greatly disagree, in their estimation of a bisection. Thus the length of the lost standard was 0.0003 inches longer by one person's measurement than by another's; nay, was, when reversed, of a different length to what it was before.

by the same person's measurement. There is no error of any such amount to be feared in the new standard; but it is impossible to say, without trial, whether there may not be some similar error, depending on the *person*. The observer, therefore, begs earnestly that such Fellows of the Society as have any acquaintance with micrometrical measurements, or who, having good eyes and nice fingers, can give a little time to learn to make such measurements—the simplest and easiest possible—will inform him of their readiness to assist. With a little help of this kind, the work will now go on much more rapidly than hitherto.\*

Another planet, named by M. de Gasparis, its discoverer, *Hygeia Borbonica*, has been discovered in that formerly vacant interval between *Mars* and *Jupiter*, now peopled by ten of these small bodies. It seems destined that our ideas of the structure of the planetary system should undergo a great change. It is not strange that planets far beyond the furthest known should, as time advances, be discovered, but it does appear strange that planets and satellites should be discovered intervening between those formerly known. And we may well doubt whether there are not planets whose orbits lie between those of *Venus* and the Earth, and whether that body which we call the moon is the only satellite of the Earth. The importance of these discoveries is not to be judged of as merely a matter of detail, in which new particulars are simply added to old ones of the same class. Our conceptions of the structure of our system in particular, and of the sidereal system generally, may ere long be totally altered by the discovery of the almost universal prevalence of planetary and cometary bodies through all the space which our instruments command.

The past year has added two new Comets to our list, both detected in the month of April. The first was found on the 11th by M. Schweizer at Moscow, and a few hours later by Mr. G. P. Bond, at Cambridge, U.S. It was also discovered independently by Mr. Graham, at Markree, on the 14th. It was tolerably large and bright when viewed in the telescope, but barely visible to the naked eye. The orbit does not appear to differ sensibly from a parabola, this curve satisfying the observations within their probable limits of error, and better than any ellipse. The conjecture as to the identity of this comet with the second of 1748 is, therefore, inadmissible.

The second comet was detected by M. Goujon, at the Observatory of Paris, on the night of April 15. It was not visible without optical aid, but remained in sight to the large telescopes at the command of several of our Fellows until the latter end of September. It has no resemblance to any of the comets previously calculated. The whole course of observations is perfectly represented by a parabolic orbit.

\* An Arnott's stove has been recently fixed in the observing vault; and it is intended to keep the temperature at a comfortable point.

The disappearance of *Saturn's* ring, which had occurred before the Anniversary Meeting of last year, and which enabled Mr. Bond and Mr. Lassell to discover a new satellite, gave also the opportunity of making many other physical observations on that remarkable planet. Among these, the Council attach a high value to the micrometrical measures of different diameters of the planet, made at the Royal Observatory by the Rev. R. Main, first assistant in that establishment. Judging by the eye only, Sir W. Herschel conceived that the form of the planet deviated from the elliptic spheroid by considerable protuberance at middle latitudes. The Astronomer Royal, in a paper published many years since in the *Cambridge Transactions*, showed that such a form could not be explained by the attraction of the ring. Mr. Main's measurements have shown beyond doubt that the form of the planet does *not* differ from that of the elliptic spheroid; and the Council have the very great satisfaction of stating that Sir John Herschel, with his usual frankness, has communicated to Mr. Main his avowal that Mr. Main's observations are perfectly decisive on this point, and that there cannot remain the smallest reason for suspecting the existence of this anomalous form.

Among the official astronomical publications of the British Government, the Council wish to call the attention of the Society to the printing (now almost completed) of the results of the first accurate observations made at the Cape of Good Hope by Mr. Fallows, in the years 1829, 1830, 1831. In the confusion of all kinds attending the decease of the first head of an institution like the Cape Observatory, when the troubles attending the mounting of new and imperfect instruments are scarcely surmounted, and when no rule or precedent has been established for the ultimate treatment of the observations, it is not to be wondered at that there should have been delay in the definitive reduction and printing of the first Cape Observations. It is stated by the Astronomer Royal that efforts had, some time ago, been made by the Board of Admiralty for procuring the reduction and exhibition, in a proper form, of Mr. Fallows' observations. They were finally placed in the hands of the Astronomer Royal, who has completed the reductions; and by an arrangement made between the Board of Admiralty and the Council of this Society, the results of the observations in a very detailed form will be published at the expense of the Admiralty in the Society's *Memoirs*. While the Council congratulate the Society and astronomers in general on the preservation of observations which will, probably, be regarded as the foundation of astronomy in the southern hemisphere, and on an act of justice to the memory of Mr. Fallows, they also rejoice to see that another proof has been given that the well-directed acts of the dead do not die with them, and that the astronomer who, under difficult circumstances, steadily and conscientiously labours at the work which his position prescribes, may be assured that his successors, if not his contemporaries, will set the proper value upon it.

and that the publicity which he may not live to see will assuredly be given to it at some later time.

The gigantic instrument of the present day, and that by which this period will, perhaps, be most distinguished to future ages, is Lord Rosse's 6-foot reflector. In successive communications made to the Society by the Astronomer Royal, which are printed in great detail in our *Monthly Notices*, information has been given to the Society of the powers of this instrument, and of the difficulties and the successive steps of improvement in its mechanical arrangements. In the last of these communications the Society will have had the satisfaction of learning that the mounting now adopted for the mirror appears to be perfect; and we may hope before long to learn the results of these observations of the most difficult class, for which extreme beauty of definition, as well as great light, are necessary.

The method of treatment of the observations of double stars for the determination of their relative orbits has been put by Sir John Herschel into a most elegant form, in which, perhaps, the graphical and the algebraical parts are more clearly distinguished than they had formerly been. Accompanying Sir John Herschel's communication were notes from M. Yvon Villarceau, of the Observatory of Paris, containing explanations of a method in some respects similar to Sir John Herschel's, with applications of it to some of the most remarkable double stars. In these notes, M. Yvon Villarceau has not contented himself with investigating orbits, but has shown that, even after discussing large masses of the best modern observations, the elements of the orbit may be indefinite, and that nothing but observations at a distant time can successfully be used for removing this indefiniteness. In alluding to this subject, the Council must not omit to state that M. Yvon Villarceau, in a communication to the French Institute, has very carefully discussed the evidence for the applicability of the law of gravitation to the relative motions of double stars (which, undoubtedly, has been assumed rather hastily). His conclusion is, that the evidence does not authorise us to say that it is certain that this law applies to the double stars, but only that it is probable.

The allusion to a subject, in which the value of the observations depends on the accuracy of the micrometrical measures, suggests to the Council the remarks made by Mr. Hind on the discordance in the measures of the distance of *Neptune's* satellite, and the great effect which it produces in the resulting mass of that planet. Remarkable the great importance of that mass in reference to one of the most interesting problems in physical astronomy that the world has ever known, the Council express their earnest hope that the doubt may be removed, by numerous and careful measures, made by those persons who possess the instrumental means required for them.

A valuable paper on Irradiation has been presented to the So-

ciety by Professor Powell. The Council attach great importance to every investigation applying to those optical circumstances which affect observations (so to speak) in their very birth, and whose effects cannot be removed by any subsequent treatment. They wish to apply the same expressions to the investigation by Professor Challis (which has lately reached them), on the method of correcting the errors of transits for the effect of erroneous form of the pivots.

One of the last communications which has reached the Society is a paper from our esteemed Associate, M. Otto von Struve, on the suspected parallax of the star *Groombridge 1830*. By a most careful series of comparisons in declination with the neighbouring stars, made by means of the micrometer attached to the great equatoreal telescope at the Observatory of Poulkova, M. Otto Struve appears to have proved incontestably that the parallax of this star is totally undiscoverable by the best instrumental means of the present day.

A series of observations for the same purpose, but with less efficient instruments, was made at the Royal Observatory, and is printed in the *Observations* of 1847. The discussion of these results is not yet published, but it appears that they lead to the same general conclusion as M. Otto Struve's; namely, that the parallax of *Groombridge 1830* cannot, at the utmost, exceed a small fraction of a second.

Previously to the last Anniversary Meeting of the Society, the new method of observing transits, introduced in America by Dr. Locke and Professor Mitchell (in which the touch of the finger is substituted for the perception of the ear, and the impress of a galvanic magnet upon a sliding piece of paper is substituted for a record in an observing-book), had been communicated to the Society. It has again been brought more prominently before us by the President, in an oral statement, subsequently printed in the *Monthly Notices*, in which the inconveniences as well as the advantages of the method are explained. The Council abstain from pronouncing any positive opinion upon the advantages or probability of universal adoption of this method; but they can have no hesitation in indicating it as one which well deserves the consideration of every director of an observatory.

The department of meteoric astronomy (for the time seems to be arrived, or fast arriving, when we shall be able to use such a term with as little misgiving as we now speak of cometic) has been of late assiduously cultivated by M. Petit, Director of the Observatory of Toulouse, who has communicated to the Academy of Sciences of that city a memoir, which has appeared in their *Transactions*, on the determination of the orbits of meteors, not only relatively with respect to the earth, but absolutely with reference to the sun. This memoir contains formulæ applicable to all cases

where observations thoroughly to be depended on are procured. The meteor of the 19th August, 1847, fortunately afforded such observations; and in a letter recently addressed by him to M. Schumacher, and published in the *Astronomische Nachrichten*, No. 701, he states the following extraordinary and highly interesting result of his calculations:—

The meteor, when first seen, was at a distance from the earth's surface = 217900 metres, and when lost sight of, 68900. Its relative velocity with respect to the earth was 41700 metres per second, and its absolute velocity in its orbit about the sun, 70094. At the moment of its first apparition it was in the act of describing a hyperbolic orbit about the sun, having for perihelion distance 0.9783952, and a semiaxis of — 0.2385498, with an eccentricity, node, and inclination ascertained by M. Petit, but of no immediate interest. But since at that instant it had already undergone some effect of perturbation, both by the earth and moon, M. Petit has computed and allowed for that effect, and concludes that previous to entering the sphere of the earth's appreciable action its orbit was hyperbolic, with an eccentricity 3.95134, perihelion distance 0.05626, and semiaxis — 0.32401. This meteor, therefore, must have come from the regions of space exterior to our system, and the epoch at which it must have quitted a sphere having a radius of one parallactic unit (or the distance of a star whose annual parallax = 1") must have been no less than 373397.7 years antecedent to that of its arrival at its perihelion in 1847. This interesting body would appear, from M. Petit's calculations, to have fallen into the North Sea near the Belgian coast.

The volume of *Greenwich Observations* for 1847 (long delayed for the sake of its Appendix) has, within a few months, been published; and the Council think it worthy of special notice, on account of some important novelties. Of these, the first is the publication, in a very complete form, of the observations of the first six months with the Altitude and Azimuth Instrument—a series which, assisted by the elaborate plans and explanation of the construction of the instrument, as well as the explanation of the mode of using it, may tend to give a strong impulse in favour of the adoption of that most valuable construction. The second is, the extensive Catalogue of Stars, deduced from all the observations made at the Royal Observatory from 1836 to 1847, but printed in a form which admits of the division of these observations into two groups of six years each, accompanied with day-numbers to the end of 1860, and star-numbers for all the stars, computed in accordance with the principles of a paper printed in the *Mémoires* of this Society, the object of which was to show that star-reductions might be computed without any quantities changing their algebraical signs. The possible advantages of such a method are, of course, purely practical; but the importance of getting rid of changes of sign is recognised by every practical computer.

Mr. Bishop hopes to complete the greater number of his eclip-tical charts during the present year. The delay in their publication has arisen partly from an extension of the original plan, and partly from Mr. Hind's indisposition during the last summer. It had been proposed by Mr. Bishop to insert all stars of the *eleventh* magnitude within the limits of the map; but, to do this effectually, it was found that a much longer period would be required than if the charts were to contain stars to the tenth magnitude only. Mr. Bishop therefore intends to continue his maps on the same plan as that for Hour I., already published, which includes all stars to the tenth magnitude within  $3^{\circ}$  of the ecliptic.

Among matters of unusual astronomical interest connected with the past year, must be classed the publication of Sir J. Herschel's *Outlines of Astronomy*. It would at this moment be difficult to name a science the truths of which have been expounded to the world in so remarkable a manner, by combination of profound knowledge and power of writing with unusual opportunities of observation and of authentication. If many had enjoyed such opportunities, it would be the universal opinion that no one should write on astronomy at large who had not laboured in both hemispheres; and though the rarity of such instances makes such a restriction impossible, it enhances the value of the work now alluded to, which must long remain the most complete and most satisfactory exhibition of the science, as a whole, to the educated world, as well as a valuable manual of thought to the professed astronomer.

Among the auxiliaries which enable astronomical observations to be transformed into practical results, logarithmic tables occupy a prominent place. Capt. Shortrede, of the East India Company's service, and a Fellow of this Society, has, at an expense which would have fitted up an observatory, and with as little chance of pecuniary profit, and much personal labour, edited the largest set of logarithmic trigonometrical tables that has hitherto appeared in this kingdom. The composition and stereotyping of this work were executed at Edinburgh, and a small edition was issued in 1844, in one volume, while the author was yet in India. Some defects of execution having appeared, Capt. Shortrede, on returning to England, caused most of these copies to be cancelled; and after a thorough revision of the plates, and a recast of some of them, he returned to India early in last year, leaving directions that the trigonometrical part of the tables should be published separately. The part alluded to contains the logarithmic sines and tangents for every second throughout the quadrant, comprised in less than one-third of the bulk of Mr. Michael Taylor's volume. The principal feature of the other portion of the work consists in exhibiting, in a symmetrical form, the numbers answering to given common logarithms—a form which, in certain calculations (not astronomical) possesses advantages over its ordinary converse. As originally constructed by Dodson (1742), it was inconvenient for modern use, and had

also become scarce. The work likewise presents tables upon a new and facile principle, for obtaining logarithms to numbers, and *vice versa* to a large number of places. In the constructing and perfecting of these, two other of our Fellows (MM. Gray and Weddell), with Mr. Hearne of Sandhurst, have had a chief share. From some cause not explained, Capt. Shortrede's tables, though completed at press several months since, have only recently been obtainable in London. The author has fixed a price for the copies barely equivalent to the paper and press-work. The Council feel assured that his public-spirited munificence will be appreciated by astronomers, and that this Society will, in particular, enrol him among the benefactors of the science.

*Titles of Papers read between Feb. 1849 and Feb. 1850.*

1849.

- Mar. 9. Elements of *Iris*. Mr. Pogson.  
 Various Observations. M. Rümker.  
 Observations of the Satellite of *Neptune*. Professor W. C. Bond.  
 Observations of Planets. Professor Chevallier.  
 On the Discovery of an Eighth Satellite of *Saturn*. Mr. Tuckett.  
 On the Longitude of Hobarton. Captain Shadwell.  
 On a new Method of observing Transits. Professor Bache.  
 Observations of Solar Spots. Mr. Lowe.  
 Observations of Satellites of *Saturn*, *Uranus*, &c. Mr. Lassell.  
 Description of a Perpetual Calendar. Captain Shortrede.  
 On Irradiation. Professor Powell.  
 Observations of *Neptune*. Mr. Cooper.  
 Observations of *Iris*. Mr. Boreham.  
 Ephemeris of *Iris*. Mr. Pogson.  
 Observations of *Neptune* and *Iris*. Mr. Hartnup.  
 Observations of Solar Spots. Captain Shea.  
 On a Formula in Interpolations. Rev. R. Sheepshanks.  
 Elements and Ephemeris of Petersen's Second Comet. M. Rümker.  
 Remarks on the Chronology of Lunations. Mr. Lowe.  
 On the Form of the Planet *Saturn*. Rev. R. Main.  
 On an Occultation during Lunar Eclipse, March 8, 1849. Mr. Chalmers.  
 Notice of Optical Glass. Mr. W. Simms.  
 April 13. On the Aurora of November 17, 1848. Sir A. Lang.  
 Observations of Petersen's Second Comet. Messrs. Cooper and Graham.

1849.

April 13. D'Arrest's Elements of Petersen's Second Comet. Professor Schumacher.

Observations. M. Rümker.

Elements of Petersen's Second Comet. Mr. Safford.

On the Lunar Eclipse of March 8, 1849. Mr. Hind.

On the Lunar Eclipse of March 8, 1849. Professor Challis.

On the Astronomer Royal's Method of ascertaining the true Diameter of *Venus*. Rev. R. Sheepshanks.

On the Determination of the Orbits of Binary Stars. Sir J. Herschel.

Observations of Solar Spots. Captain Jacob.

On an Adaptation to the Eye-piece of a Telescope. Rev. J. B. Reade.

Appendix to Sir J. Herschel's Paper. The Astronomer Royal.

On Calculating the Moon's Place for Ephemerides. Mr. Drach.

Facts bearing on Irradiation. Captain Shortrede.

Observations of Wilmot's Comet. Mr. Maclear.

May 11. Observations of *Iris*. Mr. Hartnup.

Orbits of Double Stars. Mr. Hind.

Discovery of a Comet, Observations and Orbit. Mr. Graham.

On a new Comet. Professor W. C. Bond.

Circular respecting new Comet. Professor Schumacher.

Ephemeris of *Metis*. Mr. Gould.

Observations of Satellites of *Saturn*. Mr. Lassell.

Ephemeris of *Metis*. Mr. Graham.

On Rating Chronometers at Sea. Mr. Toynbee.

Observations of *Flora*. Mr. Hartnup.

Ephemeris of *Flora*. Dr. Brünnow.

On Schweitzer—Bond's, and Goujon's Comet. Professor Schumacher.

On the Solar Spots. Lieut. Hardy.

June 8. Note on the Mass of *Uranus*. Mr. Adams.

Ephemeris of *Iris*. Mr. Pogson.

Observations of *Flora*, &c. Mr. Hartnup.

On the intended Chronometric Junction of Boston and Liverpool. Professor W. C. Bond.

Observations and Elements of Schweitzer's Comet. Professor W. C. Bond.

Circulars on Schweitzer's and Goujon's Comets, &c. Professor Schumacher.

Observations of De Gasparis' Planet. Professor Schumacher.

Ephemeris of De Gasparis' Planet. Mr. H. Breen.

Observations of De Gasparis' Planet. M. Rümker.

Observations of De Gasparis' Planet. Mr. Hind.

1849.

- June 8. Ephemeris and Elements of *Metis*. Mr. Graham.  
On the Discovery of De Gasparis' Planet. M. Cappocci.  
Description of a Transit Room. Mr. Dell.  
Diagrams of Solar Spots. Captain Jacob.  
On Double Stars. M. Villarceau.
- Nov. 9. Observations. M. Rümker.  
Observations. Mr. Hartnup.  
On an Improved Compensation Balance. Mr. Hartnup.  
Ephemeris of *Metis*. Mr. Graham.  
Note on Brorsen's First Comet, 1846. Mr. Hind.  
Observations of *Hygeia*. M. Scarpellini.  
Observations of *Hygeia*. M. Santini.  
Note on the Mass of *Neptune*. Mr. Hind.  
Note on Polishing Specula. Mr. Lassell.  
On the Fourth Satellite of *Saturn*. Mr. Lassell.  
Observations of Goujon's Comet. Mr. Boreham.  
Ephemeris of Goujon's Comet. Mr. Pogson.  
On a new Term in the Lunar Theory. Professor Hansen.  
Observations of Goujon's Comet. Mr. Lassell.  
Observations of Comets. MM. Cooper and Graham.  
Observations of Goujon's Comet. Mr. Lassell.  
Ephemeris of *Hygeia*. Mr. Graham.  
Ingress of *Mercury*, Nov. 9, 1848. Mr. Luff.  
Observations of Planets and Comets. Mr. Hartnup.  
Observations of Gambart's Comet. Mr. Maclear.  
Observations of *Metis*. M. Rümker.  
Ephemeris of De Vico's Comet. Professor Chevallier.  
Notices of *Saturn*. Mr. Bond.  
Ephemeris of *Metis*. Mr. Graham.  
Notice on Falling Stars. Mr. Lowe.  
On the Anglo-Saxon Yard. Mr. Wackerbarth.  
Account of a Meteor. Mr. Webb.  
Occultations observed at Ashurst. Mr. Snow.  
Ephemeris of *Metis*. Mr. Graham.  
Observations of Goujon's Comet. Mr. Lassell.  
Observations of *Metis*. M. Rümker.
- Dec. 14. Observations of Stars compared with Goujon's Comet.  
Mr. Hartnup.  
Diameters of *Venus*. Mr. Lassell.  
On a Calculating Machine. Mr. Drach.  
Diameters of *Venus*. Mr. Hartnup.  
On Lord Rosse's great Reflector. Mr. Airy.  
On Mr. Bell's Calculating Machine. Mr. Airy.  
On Lunar Tables. Mr. Drach.  
Observations of *Metis*. Mr. Hartnup.  
Observations of *Neptune*. Mr. Hartnup.  
On Correcting the Errors of Pivots of Transit Instruments. Professor Challis.

1849.  
Dec. 14. On the Appulse of *Jupiter* and the Moon, Dec. 7, 1849.  
Captain Shea.
1850.  
Jan. 11. Errors in Shortrede's Logarithms, second edition. Mr.  
Gray.  
Various Observations. M. Rümker.  
Observations of *Neptune* and *Metis*. Mt. Hartnup.  
On a new Method of Mounting an Equatoreal. Mr.  
Cowper.  
On *Saturn's* Ring. Rev. R. Dawes.  
On the Construction of an Observatory. Mr. Drew.  
On a Spiral Calculator. Rev. T. P. Dale.  
On a Speculum Polishing Machine. Mr. Hippisley.  
On Halley's Comet, &c. Mr. Hind.
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*List of Public Institutions and of Persons who have contributed  
to the Society's Library, &c. since the last Anniversary.*

Royal Society of London.  
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Ditto ditto, Bombay Branch.  
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L'Académie Impériale des Sciences de St. Pétersbourg.  
L'Administration Impériale des Mines de Russie.  
The American Philosophical Society.  
The American Academy of Arts and Sciences.  
The Smithsonian Institution.  
British Association.  
Royal Academy at Brussels.  
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*Address delivered by the Astronomer Royal, President of the Society, on presenting the Honorary Medal of the Society to M. Otto von Struve.*

It has been stated to you, Gentlemen, in the Report of your Council, that the Medal of the Society has been awarded to M. Otto von Struve, for his paper entitled, "*Bestimmung der Constante der Präcession mit Berücksichtigung der eigenen Bewegung des Sonnensystems*," communicated to the Academy of St. Petersburg on the 19th of November, 1841, and printed in the third volume of their *Mathematical and Physical Transactions*, sixth series; and it is now my most agreeable duty to point out to you the state of the questions to which this paper relates, the need for a new investigation, the skill and care with which M. O. Struve's investigations have been conducted, and (in a word) the claims which the selection of the subject and the mode of treating it have presented for the honourable notice of the Society.

The subject of precession, generally, has always appeared to me one of the highest interest in physical astronomy. Its discovery, as an astronomical fact, dates from the earliest age of scientific astronomy. Its existence was recognised, and its quantity tolerably well measured, by the astronomers of the succeeding ages. But century after century rolled away, and no human being entertained the smallest idea of its cause. It stood as an anomalous fact, perfectly certain in its existence, perfectly clear in its law, but unconnected in its form, or in its probable causes, with any other phenomenon known to man. The establishment of the Copernican theory did not appear likely to aid at all in its explanation. Vortices might be conceived which would carry planets round the sun, but no vortex was devised which could give to the earth's axis the gradual change of position required to explain the fact of precession. At length Newton,—thoroughly imbued with the knowledge of the Galilean mechanics, powerful in the use of the new calculus which he had already invented, ready to invent newer methods whenever they should be required,—examined in a mechanical point of view the principal laws of the planetary motions, and the principal perturbations of the moon, and explained them fully by his theory of gravitation. But a part only of the theory was required in these explanations. It sufficed, in regard to the attractions, to consider the attraction and the liability to attraction, of every body in the solar system, as being fixed in its centre. It sufficed, in regard to the laws of mechanics involved in the investigation, to consider the moving bodies as points. Had Newton stopped here, the explanations of precession, of the figure of the earth, and of the tides, would have been lost. At this distance of time I cannot refuse my admiration to the generality of conception which suggested to him that the centre of a planet can have no special virtue, except from the combination of the actions of all its parts, nor to the undeviating firmness with which he retained this conception, nor to the mathematical sagacity with which he perceived that one of the consequences of this conception must be an ample explanation of precession and the related phenomena. But in what form was this explanation to be put? At the present time, the explanation of precession, from its mechanical causes, in a form which shall be extensively intelligible, is one of the most difficult practical problems that I know. In the first place in which Newton treats of it, he derives its explanation, by a very simple analogy, from that of the motion of the plane of the moon's orbit; and I believe that this is still the easiest illustration that can be offered. In the second place, where he makes it a matter of calculation, he abandons that form, and treats it (as it ought finally to be treated) as a case of the theory of rigid bodies. A small error was made in this theory; but it was unimportant. Regarding its object as being this, to show that the phenomenon, generally, was explained, and that its magnitude was computed as nearly as could be expected, it was perfectly successful. And I have no hesitation in expressing my belief that, if I had lived in

that critical time of science, the explanation to which I should have appealed as establishing the truth of the theory of gravitation, would have been the explanation of precession.

Among the applications of our knowledge of precession, the most striking, perhaps, to ordinary imaginations, is that which connects it with the broader and coarser features of very ancient chronology. The stars over which the colures have passed in succession, as one century after another has slipped away, may well be described in the words of a modern poet, applied to a different kind of memorial,—

“ Like dials, which the wizard Time  
Had raised to count his ages by.”

In some instances, undoubtedly, this use of the theory has been abused; in all it is liable to considerable uncertainty. Nevertheless, it is one which sometimes gives us information when all other sources fail. And nothing appears more marvellous than that it should be possible, from a single well-authenticated shepherd's observation of the heliacal rising of a star, to infer the date with a precision much exceeding that of many of the records of history.

To the practical astronomer, however, of the present day, the exact knowledge of the law and magnitude of precession is more necessary for another reason. Not a single observation can be properly reduced, not a clock-error can be investigated, not a place of sun, or moon, or planet, or comet, can be brought to a state in which theory can be confronted with observation, without an accurate knowledge of precession. And it is this, in fact, which has given rise to the necessity for repeated investigations of the numerical value of the constants of precession.

In this, as in all other cases of natural philosophy, the more the accuracy of observations is increased, the greater becomes the complexity of the laws of nature which it is necessary to take into account; and the investigation, which at first was intended only for the purpose of correcting the numerical coefficients of a known theory, may lead to the discovery or verification of a subordinate theory of a totally different kind. We shall find that this very circumstance occurs in the investigation which is now before us.

The determinations of precession to which, by common consent, the astronomers of Europe had referred before M. O. Struve's investigation was undertaken, and which, in fact, are most generally used at the present time, are Bessel's. They were made at two successive steps. The first of these is detailed in the “*Untersuchung der Grösse und des Einflusses des Vorrückens der Nachtgleichen*,” a paper honoured with the prize of the Berlin Academy; its last alterations are dated 18th August, 1815. The subject of precession is treated in this paper by a comparison of Bradley's places of 2429 stars in north polar distance, and 2278 stars in right ascension, with the places in Piazzi's two catalogues. It is needless for me to trouble you with details of the division of the heaven into

zones, and of the subdivision of each zone into portions, or of other devices suggested by the author's well-known skill. But it is important to remark that Bessel fully recognised the difficulties introduced by the proper motions of the stars and the probable movement of the solar system, and that he pointed out a certain degree of regularity in the discordances of results, which however, in his opinion, was not at all favourable to Sir William Herschel's supposition that the motion is directed towards the constellation *Hercules*. These difficulties he hoped to overcome by using for the comparison a large number of stars. He also remarked critically on the possible errors of Piazzi's catalogue, as inferred from his discordant determinations of the obliquity at the two solstices, and on the effect of those errors. And he treated the immediate results of his investigation with due reference to the difference between general and luni-solar precession, and founded upon that difference deductions as to the mass of *Venus*.

In the Berlin *Memoirs* for 1818-1819, Bessel gave his catalogue of 36 stars, founded upon his own observations and his own determination of the equinoxes, using Von Lindenau's new coefficient of nutation in the reductions. In the *Memoirs*, 1825, he gave new determinations of right ascension of the same stars, founded on observations made with his new meridian instrument. And in the *Astronomische Nachrichten*, No. 92, he brought together these results, compared them with those which would have been obtained from Piazzi's catalogue if corrected by Von Lindenau's nutation, and used the comparison to correct the coefficients of precession found in the first investigation. And these corrected coefficients are those used in the *Tabula Regiomontana*, and usually referred to as Bessel's coefficients.

It will be seen from the account which I have given that, though the first determination was made by means of 2400 stars, yet the places at one end of the period are, in fact, carried on by the observations of thirty-six stars; and that the determination is sensibly affected by the use of a coefficient of nutation now generally allowed to be erroneous.

Some time after this, the attention of astronomers was drawn pointedly to the theory of the proper motion of the solar system. The first enunciation of this theory had been given by Mr. Herschel (afterwards Sir William Herschel) in the *Philosophical Transactions*, 1783. In the first place, he had taken Dr. Maskelyne's proper motions of *Sirius*, *Caster*, *Procyon*, *Pollux*, *Regulus*, *Arcturus*, and *♌ Aquila* (all in right ascension, and *Sirius* and *Arcturus* in polar distance), and had shown that all these motions are explained by a motion of the solar system towards *Hercules*. He then took twenty-seven proper motions, given by Lalande for fourteen stars, and showed that twenty-two of them are explained by motion towards *♌ Herculis*. He then took forty-four different stars from Mayer, and showed that the proper motions of thirty-two of them agreed with the same hypothesis. In the *Philosophical Transactions*, 1805, he again took up this subject, and he investi-

gated the pole of intersection of the apparent paths of several pairs of stars. But the most remarkable evidence which he found for his conclusion was thus obtained. The sum of the annual apparent motions of *Sirius*, *Arcturus*, *Capella*, *α Lyre*, *Aldebaran*, and *Procyon*, was found to be  $5''.35$ . But supposing that the movement of the solar system is towards a point, R.A.  $245^{\circ} 52' 30''$ , N.P.D.  $40^{\circ} 22'$ , and supposing that so much of the proper motions of the stars as is directed towards that point is entirely due to solar motion, then the sum of the residual proper motions is only  $0''.96$ .

It is unnecessary for me to say at length how this theory was supported by some astronomers, as Prevost and Klügel, and how it was doubted by others, as Maskelyne, Burckhardt, and Von Lindenau. Bessel, in the 12th section of the *Fundamenta* (published in 1818), gave a series of numbers defining the directions of the proper motions of seventy-one stars (including all the stars of the *Fundamenta* whose proper motion amounted to  $0''.5$  annually), and simply remarked on these that they did not confirm Herschel's theory. No important addition was made to the investigation until Argelander took it up, in a paper communicated to the Academy of St. Petersburg in 1837, and printed among their *Divers Savans*, tom. iii. The foundation of this investigation was Argelander's own admirable catalogue of 560 stars for 1830 (published in 1835), and the proper motions which accompany it. Of these 390 were found available for his purpose. He proposed to treat these proper motions by the method of minimum squares; and the first question was, What ought to be selected for the nature of the residual error, the sum of the squares of which for all the stars should be minimum? The quantity which he adopted was the angle (expressed in degrees not numerically exceeding  $\pm 180$ ) between the direction of the star's proper motion and the great circle connecting the star with the pole of solar motion, multiplied by the sine of the star's distance from that pole, without any reference to the amount of the proper motion or to the star's brightness. The result, corrected for some errors, is given in the *Astronomische Nachrichten*, No. 363, the place of the pole of solar motion is found R.A.  $259^{\circ} 52'$ , N.P.D.  $57^{\circ} 31'$ . Lundahl (*Astron. Nach.* No. 398), by an application of the same method to a comparison with 147 of Pond's catalogue of 1112 stars, which had not been included in Argelander's catalogue, found results considerably different, especially in declination. It is proper to state that Mr. Galloway, in a paper printed since the appearance of that which is the subject of our medal, has applied Argelander's method to the southern stars; his resulting R.A. is greater, and his N.P.D. less than Argelander's.

The state of the matter when M. Otto Struve undertook his investigation may now be well understood. The determination of precession, though undoubtedly good, admitted probably of improvement. A new element of reduction had attracted general attention; the evidence for its existence, with elements expressible numerically by a measurable or definable quantity, had become too

strong to be neglected ; at the same time that the form of the latest investigations, founding their measures of error on circular angles, and omitting absolutely the consideration of probable distance, might not be satisfactory to every investigator.

The difficulties of this investigation, when fully considered, are almost bewildering. So long as we conceive any one material body to be fixed, our notions of motion, whether of translation or of rotation or revolution, are perfectly clear ; but when once we give up the idea of material immobility, we soon perceive that the notion of a zero, either of linear measure or of angle, is a purely metaphysical conception. In applying it to nature we must assume something as arbitrary.

The stars used by M. Otto Struve are 265 double stars, and 74 pairs of stars too widely separated to be included under the same term, of which the right ascensions and north polar distances had been observed by M. Struve at Dorpat : Maskelyne's 36 stars (some of which are included in the former list) ; 42 circumpolar stars, which had been repeatedly observed with reference to the theory of refraction ; and 39 stars not included in either of these lists. The whole number is 400. The places of the stars are not reduced to one epoch, but each star is reduced to the beginning of that year which corresponds most nearly with the mean of its times of observation, Argelander's proper motions being applied as far as they go, and in some other instances proper motions deduced from a first approximate comparison with the *Fundamenta* being applied. The daily reductions of the star-places were made by means of the numbers in the *Tabulæ Regiomontanæ*. The clock-errors were obtained from the fundamental catalogue in the introduction to the *Dorpat Observations*, vol. vi., the place of the equinox being there determined by 216 observations of the sun distributed over eight equinoxes. Ample proofs are given by Mr. Otto Struve of the accuracy of his individual results. The only possible objection which could be advanced to these determinations for the second of the epochs of comparison, is the preponderance of double stars, whose proper motions, in general, follow peculiar laws. Of those here used, however, the vast majority, without doubt, are only optically double, and no such objection applies to them. And in every other respect the accuracy of the determinations is probably equal to that of any mass of star-places that has ever been collected.

The geometrical annual precessions were then computed for every star for three different epochs, namely, Bradley's epoch, 1755 ; O. Struve's epoch (which, as is mentioned, is different for different stars) ; and for the epoch half way between them. An approximate formula founded on these gave with facility the whole geometrical precessional motion, accurate to the third power of the time. The comparison of this with the difference between Bradley's and O. Struve's catalogue, gave the proper motion affected by the errors of precession.

And now the metaphysical difficulty to which I have alluded

comes into play. M. O. Struve, in the first portion of the investigation, eluded a part of the difficulty by assuming as established that the solar system does move towards the point finally indicated by Argelander. Still we have not delivered ourselves from difficulties. The zero of angle in the celestial sphere will evidently change according to the magnitude which we attribute to the apparent motions of stars right and left of that pole of the sun's motion, so far as the apparent movement of the stars depends on the sun's motion. What law applying to these parts of the star's apparent movement,—or, in other words, what law of the distance of the stars,—shall we assume? After showing that the proper motions are really (upon the whole) largest for the brightest stars, M. O. Struve finally determines on adopting the law of distance, as connected with magnitude, given by M. Struve in his introduction to the *Catalogus Novus*. I fully agree with Mr. Main (to whom the Council are indebted for a critical abstract of M. O. Struve's paper), that M. O. Struve has omitted some important criteria of distance, namely, the binary nature of the double stars and the amount of proper motion. And at the same time I agree with Mr. Main's further remark that, under all circumstances, there was nothing better to be done for the mass of stars than to adopt the rule which M. O. Struve has adopted. For the stars of less brightness, the stars of one magnitude are assumed to be at one distance; but the stars of the first magnitude are subdivided into several groups of distances. After all, M. O. Struve has thought it necessary to exclude seven small stars of extraordinary large proper motion, as either having peculiar movements in space too large to be tolerated in such an investigation, or as being much nearer to us than Struve's rule of distances would place them.

Equations were then formed, expressing the numerical discordance of the computed and the observed precessional motion by two symbolical terms: one multiplying a correction of the principal term of precession, the other multiplying a symbol expressing the apparent angular motion of the sun in ten years, as viewed from a fixed star, at the mean distance of stars of the first magnitude, in a direction at right angles to its linear motion. This second coefficient was always affected by the star's assumed distance as denominator.

The equations in this shape, M. O. Struve remarks, would give an overwhelming influence to the bright stars; and, therefore, he reduces their weight by a factor founded on the assumption that the uncertainty on the discordance of the two catalogues for a star of the sixth magnitude is equal to the average proper motion, during seventy years, of a star of the sixth magnitude, and equal to the sun's angular motion in the same time: and he represents the whole probable error,  $5''.5$ , by the square root of the sum of their squares. For stars of other magnitudes he retains the first term unaltered, but increases the second and third in the inverse proportion of their distances; and thus he obtains a larger probable error or a smaller weight for the equations for the near stars.

The selection of this form of equations, combined with one of which I shall speak shortly, amounts to this, that upon the whole mass of stars, as far as we are able to form a conjecture of their positions in space, we assume that the algebraic sum of their movements in space estimated in any one direction = 0, and we also assume that the algebraic sum of the geometrical moments of their motions round any one point = 0.

With the equations affected by these weights, he obtains as result, that Bessel's first coefficient of precession in right ascension ought to be increased by  $+1''.65$ ; that his second coefficient ought to be increased by  $+0''.24$ ; and that the sun's angular motion in ten years (seen as is above mentioned) is  $3''.15$ .

But when these numbers were substituted in the original equations, so as to exhibit the residual errors, it appeared that the numerical quantity for error of observation was too great. A new assumption was then tried, namely, that the probable error of determination is half the value of average proper motion of a star of the sixth magnitude; and the equations were solved anew. The results were very little altered.

The star-corrections in the original investigation of observed places, it is to be remarked, had been reduced with the tables of the *Tabulæ Regiomontanæ*, and, therefore, with Von Lindenau's nutation. But as the investigations of Busch and Peters had now proved beyond doubt that a value of nutation, somewhat different from those adopted in the reductions for either epoch, was nearer the truth, the proper correction was applied for the change. The final result is, that the coefficient of general precession is  $50''.235$ .

And, adopting  $0''.2$  as the annual parallax of an average star of the first magnitude, the sun's annual motion is found to be  $1\frac{1}{2}$  times the radius of the earth's orbit. This linear motion appears to be less than that of stars in general.

M. O. Struve then enters into an investigation of the correction of Argelander's point, by finding symbolically the variations of the expressions for the effect of solar movement, as depending on the variation of the right ascension and polar distance of that point; the numerical value already found for the quantity of solar motion, and the proportion of distances of the stars, being adopted as known elements. The quantity which is exhibited as error, to be reduced by the method of least squares, is the amount of proper motion in right ascension and in polar distance yet to be explained. The weight given to each equation is the same as that in the former investigations. A point is thus found, several degrees north of Argelander's final point, and having greater right ascension, but not very distant from that first found by Argelander. This investigation appears to me the most satisfactory that has been made. But another investigation, which is subjoined to it, tends in no small degree to injure the credit of this and of every other investigation directed to the same object. M. O. Struve examines the effect of supposing a small constant error to exist in all the decli-

nations of one of the two catalogues compared; and he finds, that if all Bradley's declinations are diminished a single second, the pole of solar movement will be shifted twenty degrees to the south. I have personally no belief in the freedom of Bradley's declinations from a constant error exceeding a second, even as depending solely on the mean wearing of his quadrant-centre during the time of his observing with it; and I therefore am induced, by M. O. Struve's remarkable conclusion, to look upon all these determinations of the pole of solar movement with doubt, at least as regards the declination of the assigned point.

I have entered into unusual details, Gentlemen, upon this paper, because I felt that without them I could scarcely explain to you its peculiar merits. The problem of the determination of precession, roughly considered, is extremely simple; but, considered with reference to these minute circumstances which are exhibited only in large masses of observation of the most delicate kind, it is extremely complicated. I have no hesitation in expressing my own opinion that M. Otto Struve has grappled with the various difficulties that present themselves, metaphysical and mathematical, better than any other astronomer whose work on the same subjects I have examined. The two investigations which relate to the determination of the direction and magnitude of the solar movement are, in my opinion, very admirable; but the third, which exhibits the amount of uncertainty in the result depending on venial or probable errors of observation, is, in my judgment, even more valuable. I esteem a rational doubter in science as I esteem a Niebuhr in history—as the only person who is likely to supply at last a firm foundation upon which a solid superstructure may be built.

From what I have already said, you will have gathered my opinion that the subject is not yet entirely exhausted. In the first place, I observe, that the remarks upon the effect of a constant error affecting the declinations of all the stars in the same way suggest the propriety of investigating the effect of an error which affects half the stars in one way and half in another; for such an error does actually exist in the reductions of the stars with an erroneous nutation. In the second place, I trust that no great number of years will elapse before it will be practicable to compare the results of observations made at both epochs with circular instruments; for I have little belief that the results of observations with the quadrant can be free from constant error, of magnitude sufficient seriously to vitiate the final inference. In the third place, I should be glad to see the results of comparisons of the observations of stars which are not ostensibly confined to one class, as that of double stars. And since the date of the investigations of M. Otto Struve, more ample means of an unobjectionable character have been collected. For I must remark that a rather unusual delay has occurred in our notice of this paper. This has arisen partly from the delay which usually occurs in the printing and distribution of foreign memoirs; partly from the time which is necessary for thoroughly reading a paper of

such length; but principally from the occupation of the minds of astronomers, as well within as without the Society, by the remarkable planetary discoveries made in several years past.

But these remarks are entirely prospective, and have nothing to do with our opinion on the merits of the paper before us, or on its claims to the warmest expression of the high estimation of this Society. I am sure, Gentlemen, that those who have been able to follow the account which I have endeavoured to give of the state of our knowledge of the subjects to which it refers, of the skill and caution with which these subjects are here treated, and of the peculiarly valuable character of the results obtained, negative as well as positive, will agree with me, that on two of the most interesting subjects in astronomy (the precession of the equinoxes and the solar movement) M. O. Struve has given to the world a paper of the most important character, worthy of himself and worthy of the name which he bears. On the award of the Council, and I am sure with your full approbation, in the name of the Society I deliver to our Foreign Secretary, to be transmitted to M. Otto von Struve, the Medal of the Society.

*The President then, delivering the Medal to Mr. Hind, Foreign Secretary, addressed him in the following terms:—*

In transmitting this medal to M. Otto von Struve, convey to him our assurance that this Society, in common with all the astronomers of the civilised world, regard with the utmost interest the investigations conducted by his father, by himself, and by his colleagues, in regard to those points of astronomy which have now for some years been the distinctive objects of pursuit at the Observatories of Dorpat and Pulkowa. And express to him our confidence, that both in his connexion with the astronomical observations of Pulkowa and in his superintendence of the astronomical operations of the Russian Survey, his life will be distinguished by a series of investigations equally interesting and equally successful with that which forms the subject of the present Medal.

The Meeting then proceeded to the election of the Officers and Council for the ensuing year, when the following Fellows were elected:—

*President:*

G. B. AIRY, Esq. M.A. F.R.S. Astronomer Royal.

*Vice-Presidents:*

REV. ROBERT MAIN, M.A.

Lieut. HENRY RAPER, R.N.

EDWARD RIDDLE, Esq.

REV. RICHARD SHEEPSHANKS, M.A. F.R.S.

*Treasurer:*

GEORGE BISHOP, Esq. F.R.S.

*Secretaries :*

AUGUSTUS DE MORGAN, Esq.  
 Captain R. H. MANNERS, R.N.

*Foreign Secretary :*

JOHN RUSSELL HIND, Esq.

*Council :*

J. C. ADAMS, Esq. M.A. F.R.S.  
 ARTHUR KETT BARCLAY, Esq.  
 Captain A. BRIDPORT BECHER, R.N.  
 Rev. GEORGE FISHER, M.A. F.R.S.  
 JAMES GLAISHER, Esq. F.R.S.  
 JOHN LEE, Esq. LL.D. F.R.S.  
 CHARLES MAY, Esq.  
 WILLIAM RUTHERFORD, Esq. LL.D.  
 Captain W. H. SMYTH, R.N. K.S.F. D.C.L. F.R.S.  
 J. W. WOOLLGAR, Esq.

The eighteenth volume of the 4to *Memoirs* will be published on March 25th, with three engravings. The price is 7s. 6d. to Fellows of the Society, and 15s. to the public. Vol. IX. of the *Monthly Notices*, which contains the observations, shorter and less abstruse memoirs, abstracts, lectures, &c., is given to purchasers of the 4to Volume. The two publications are supplementary to each other, and are to be considered as parts of the same series. They contain scarcely anything in common, except the annual report, and between them include a complete account of the proceedings of the Society during the year.





## ROYAL ASTRONOMICAL SOCIETY.

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Rev. R. SHEEPSHANKS, Vice-President, in the Chair.

Lieut. Alexander Ross Clarke, R.E., was balloted for, and duly elected a Fellow of the Society.

The editor of the *Nautical Almanac* has had the kindness to forward several copies of the *Supplement* for 1853, containing *Ephemerides* of the newly-discovered planets for the present year. These are for distribution among the Fellows who wish to observe the faint planets.

Among the presents received by the Society, there is one which demands particular notice, viz. a new *Astronomical Journal*, published monthly at Cambridge, U.S., of which four numbers have already appeared. The editor, Dr. Benjamin Apthorp Gould, Jun. states in a short preamble, that this is "a pure scientific journal devoted exclusively to astronomy and its kindred departments of inquiry," and expresses an opinion that astronomy has already reached a stage of developement in America which justifies the hope that such a publication will be adequately supported. The principal memoirs which have appeared, or are in the course of publication, are,—*Development of the Perturbative Function of Planetary Motion*, by Professor Pierce; *Zodiac of Hygeia*, by Professor Hubbard; *On the Orbit of the Great Comet of 1843*, by Professor Hubbard; *On the Velocity of the Electrical Wave through a Metallic Circuit*, by Professor O. M. Mitchell; *Observations of Metis*, by Mr. James Ferguson, at Washington, and by M. C. Rümker; *On the Phenomena attending the Disappearance of the Rings of Saturn*, by Mr. G. P. Bond; *On the Helio-centric Place of Neptune*, by Professor Coaklay; *Note on the Parallelogram of Forces*, by Professor Pierce. Each number is a handsomely printed sheet in 4to. All communications are to be addressed to the editor, B. A. Gould, Jun., Cambridge, Mass. A volume will consist of twenty-four numbers, with a table of contents and alphabetical index. The price of subscription, five dollars, payable in advance. Mr. John Chapman is the London agent.

## VESTA.

LIVERPOOL.				Equatoreal.				(Mr. Hartnup.)				
1850.	Greenwich M.T.			R.A.		N.P.D.		Comp <sup>d</sup> .—Obs <sup>d</sup> .		Stars of Comp.		
	h	m	s	h	m	s	s	R.A.	N.P.D.			
Jan. 26	10	14	19.8	7	9	14.56	65	23	40.2	+2.26	+16.8	$\mu$ , $\beta$ Geminor.
Feb. 12	10	26	9.3	6	56	35.36	64	28	17.7	1.84	13.1	$\delta$ , $\beta$ Geminor.
	13	8	43	56	8	57	26	2	1	2.00	13.0	— —
	16	7	34	54	55	76	19	24	3	1.68	12.4	— —
	20	8	14	53	44	22	64	11	26.0	1.87	10.8	— —
	28	11	3	53	0	39	63	59	12.9	1.66	9.7	— —
Mar. 10	10	44	4.6	55	2	77	50	32	2	1.60	9.0	— —
	11	7	40	6	55	22.13	63	50	4.1	+1.77	+10.3	— —

"The observations are corrected for refraction and parallax. The computed places of the planet and the places of the stars of comparison were taken from the *Nautical Almanac*."

## JUNO.

LIVERPOOL.				Equatoreal.				(Mr. Hartnup.)			
1850.	Greenwich M.T.			R.A.		N.P.D.		Comp <sup>d</sup> .—Obs <sup>d</sup> .		Stars of Comp.	
	h	m	s	h	m	°	'	R.A.	N.P.D.	B. A. C.	
Feb. 28	14	25	47.1	13	43 56.90	93	51 6.0	+2.31	+19.3	4571,	4665
Mar. 3	12	2	21.3	43	5.05	93	32 10.6	2.20	18.7	4571	
	9	11	58 22.3	40	44.06	92	50 12.9	2.47	19.6	4571,	4665
	10	11	53 58.4	40	16.28	42	52.5	2.58	20.2	—	—
	11	11	14 39.6	39	48.10	35	38.5	2.64	22.1	—	—
	12	11	28 11.1	13	39 17.79	92	28 3.5	+2.66	+18.4	—	—

"The observations are corrected for refraction and parallax. The computed places of the planet were taken from the *Nautical Almanac*, and the places of the stars from the catalogue cited."

## METIS.

LIVERPOOL.			Equatoreal.			(Mr. Hartnup.)				
1850.	Greenwich M.T.			R.A.		N.P.D.		Comp <sup>d</sup> .—Obs <sup>d</sup> .	Stars of Comp. B. A. C.	
	h	m	s	h	m	s	°	R.A.		N.P.D.
Feb. 20	7	16	28.9	0	30	47.20	89 58 3.1	—0.75	—4.3	95, 204
Mar. 4	7	18	11.6	0	52	47.48	87 19 14.5	0.56	1.8	324
12	7	39	45.7	1	7	49.61	85 33 42.1	—0.53	—2.5	437

"The observations are corrected for refraction and parallax. The computed places of the planet were deduced from Mr. Graham's ephemeris, published in the *Astronomische Nachrichten*, No. 700. The places of the stars of comparison are taken from the catalogue cited."

## ASTRÆA.

## LIVERPOOL.

## Equatoreal.

(Mr. Hartnup.)

1850.	Greenwich M.T.	R.A.	N.P.D.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
Feb. 13	7 12 38.4	3 14 28.96	77 19 64.6
	7 32 36.1	29.91	58.5
	7 52 34.5	30.84	51.7
	8 12 32.4	3 14 31.80	77 19 46.5

"The planet was compared with 5 *Tauri*; each determination is from a transit over five wires and the readings of two microscopes. The place of the star is from the Greenwich catalogue."

## HEBE.

## HAMBURG.

(M. C. Rümker.)

1850.	Hamburg M.T.	R.A.	Dec.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
Feb. 22	11 <sup>h</sup> 41 <sup>m</sup> 57 <sup>s</sup> .6	201° 55' 5".9	+ 6° 32' 40".0

"Apparent place of star of comparison was,

R.A. 13<sup>h</sup> 25<sup>m</sup> 36<sup>s</sup>.82      Dec. + 6° 37' 12".9

"This star was observed by Bessel once, and is 25050, 25054 of the Lalande catalogue. The R.A. of 25034 is erroneous 6<sup>s</sup> in the catalogue."

*Observations made during a Transit of the Fourth Satellite of Jupiter and its Shadow over the Disk of the Planet.* By Mr. Lassell.

1850, Feb. 28. "After an intensely cloudy day, the sky suddenly cleared at about 10<sup>h</sup> mean time; but on directing the large equatoreal to *Jupiter*, I found the air very disturbed, and unfit for either large power or aperture. I therefore went into the smaller dome, and pointed the 9-foot equatoreal to *Jupiter*, power 222.

"11<sup>h</sup> 48<sup>m</sup>, G.M.T. The 1st satellite is eclipsed; the 2d is receding eastward; the shadow of the 4th is on the face, and the satellite approaching the disk. (For brevity's sake I will designate the satellites simply by their appropriate numerals.)

"There is a striking difference in the brightness of 2 and 4: 4 is of a dull pale colour compared with 2, presenting a much greater contrast than can be supposed to arise from its greater proximity to *Jupiter*. The air is very unfavourable, the planet dancing and shuddering so that I cannot endure power 291. I do not think, after minute attention, that the *disk* of 2 is quite so large as that of 4, though, at first, the superior brightness of 2 vividly suggests the notion that it is so; 4 appears *round*, as well as 2, but 3 (*much* larger than 2) is oblong or irregular.

"12<sup>h</sup> 11<sup>m</sup>. The shadow and satellite being now equally distant

from the limb, the greater size of the shadow is most obvious; indeed it appears to be twice as great in diameter.

"13<sup>h</sup> 10<sup>m</sup>. The first satellite has now emerged, and is about three-fourths of its diameter distant from the limb.

"With 20-foot equatoreal, power 297, I measured the distance of the centre of the shadow of 4 from *Jupiter's* southern limb = 33".88. Distance of shadow from northern limb = 8".72.

13 24 0. The fourth satellite is entered upon the face, about one-third of its diameter.

13 28 0. The disk of the satellite is, I think, bisected by the limb of the planet.

13 30 49. I can just see a piece of the satellite projecting, perhaps a bare third of its diameter. The state of the air is, however, very unfavourable.

13 34 0. I have now lost sight of the satellite.

13 42 42. I begin to see again the satellite as a dusky spot on the face of *Jupiter*, near where the satellite entered.

13 46 7. It is very plain. The spot is very small, not half the diameter of the shadow. A well-defined belt is near the northern limb of *Jupiter*.

13 49 0. The satellite is entered on a course across the planet, which will apparently bring it twice as near to the northern limb as the shadow has been.

13 51 0. The satellite is fully two of its diameters within the limb. The second satellite is obviously brighter and larger than the first. Air increasingly disturbed.

14 6 0. The shadow is just touching the southern part of the belt; and the satellite, though fairly within it, is near its northern edge.

14 23 0. The shadow and satellite are now equally near the preceding and following limbs.

14 35 0. The satellite is now advanced four-tenths across the disk, and the shadow approaching the preceding limb.

"Measured the distance of the satellite from northern limb: mean of three measures = 5".50.

"In the absence of the shadow I should certainly call the satellite a *black spot*; but when compared with the shadow, its blackness is certainly much less intense. I should estimate the satellite now to be rather more than half the diameter of the shadow; the best estimate I can form is that one is double the *area* of the other. The satellite does not appear to me otherwise than *round*, so far as the agitated sky will allow me to judge. Although the satellite entered upon a belt in transiting the planet, it was never visible as a *bright spot*, though the other satellites appear almost universally as bright spots when only just entered within the limb. When the

satellite was about half across the disk, the sky became so increasingly tremulous that I found it useless to continue observing.

"1850, March 5. The early part of the evening was quite cloudy, but about 10<sup>h</sup> *Jupiter* appeared, shining through haze.

"At 10<sup>h</sup> 30<sup>m</sup>, G.M.T., the shadow and satellite are both visible, rather more than half across the disk, the shadow as a perfectly round black spot. The satellite is a small, irregular, *dusky spot*, about two diameters of the shadow north-following. Twenty-foot equatoreal employed, power 297. The satellite elongated N. and S., and not half the diameter of the shadow. The circumstances were bad, *Jupiter* never being clear during the entire transit. I made six measures, with the Munich parallel wire-micrometer, of the diameter of the shadow, the mean of which is 1".537.

"At 11<sup>h</sup> 50<sup>m</sup> 57<sup>s</sup>.5 the shadow was bisected by the planet's limb.

"At 12<sup>h</sup> 6<sup>m</sup> 41<sup>s</sup>.5 the satellite was bisected by the limb. The shadow and satellite passed over a pretty bright part of *Jupiter's* disk, a little north of the principal northern belt; yet, when the preceding limb of the shadow was nearly touching the limb of *Jupiter*, I lost sight of the satellite, and shortly afterwards recognised it as a *bright spot*, when still clearly within the planet's disk. When the preceding limbs of the satellite and planet were coincident, the satellite appeared very well defined as a bright spot, of far greater magnitude than it had when seen as a dusky spot.

"At 12<sup>h</sup> 15<sup>m</sup> the sky completely clouded.

#### Remarks.

"The phenomenon of the dusky spot, in the case of the third satellite, being changed into a bright one when near *Jupiter's* limb, seems to indicate a far greater difference of brightness between the central and circumferential parts of *Jupiter* than the unaided sense of vision would indicate; also that the fourth satellite, not exhibiting such a change even when less contrasted by transiting along a belt, must reflect very little light or have a great part of its surface covered by shades. Its roundness seems to indicate that such shades or markings must be distributed pretty evenly over its surface, and yet on this hypothesis it is difficult to explain its smallness in comparison with the shadow. Can it be that, as suggested by the comparative dulness of *Jupiter's* circumference, the central parts alone of the satellite reflect sufficient light to affect our vision?

"The sky on the 28th of February was so disturbed that I did not think that any measures of the diameter of the shadow of 4 could be got with reasonable accuracy; but, as far as I could estimate its size, I should deem it somewhat larger than the shadow of the third satellite, measured on the 5th of March. Taking it, however, at the same size, and supposing the measure of 1".50 to be correct, I make the resulting diameter of the shadow to be 3027 miles, and the diameter of the satellite (deduced from the size and distance of the sun) to be 5197 miles. I do not know whether this magnitude

is at all reconcileable with its mass (if ascertained), under any probable hypothesis of density; but it has occurred to me that careful measures of the shadows of the satellites of *Jupiter* would afford the most likely means of getting at their real magnitudes, and I propose to take every opportunity of making such observations."

*Additional Observations of the Phenomena of Jupiter and his Satellites, with the Twenty-foot Equatoreal.* By Mr. Lassell.

"1850, March 10, M.T. 10<sup>h</sup> 40<sup>m</sup>. Air less disturbed than usual. Power 316. The view of the planet uncommonly fine, with occasional intervals of atmospheric agitation. The central bright part of *Jupiter* is mottled or curdled, and indeed scarcely any part of his surface is of uniform texture.

"The southern portion is covered nearly up to the edge of the principal belt with a decided shade. With power 430 the third satellite is certainly not round, but the atmosphere is not fine enough for scrutinising satellites with this power. The fourth and third satellites are very near each other, and pretty well removed from *Jupiter*. The fourth is much paler than the third. The first satellite is obviously larger than the second — scarcely, I think, so bright.

"March 12, G.M.T. 11<sup>h</sup> 25<sup>m</sup>, power 430. The air is unusually fine. I think I never saw so fine, so powerful a view of *Jupiter*. The third satellite is approaching the following limb of the planet, whose light, diminishing the brightness and radiation of the satellite, enables me to see it with admirable distinctness. There is certainly a *spot* on the satellite's disk, in the north preceding quadrant. Its disk also seems a little flattened on the following side.

G.M.T.

- |    |    |     |   |
|----|----|-----|---|
| 12 | 6  | 34. | The limbs of the 3d satellite and <i>Jupiter</i> are in contact.  |
| 12 | 8  | 30. | The satellite appears now the most beautiful round disk, and I am certain of seeing the spot upon it.                   |
| 12 | 11 | 48. | The satellite bisected by <i>Jupiter's</i> limb.  |
| 12 | 16 | 6.  | The following limbs of the planet and satellite in contact.   |
| 12 | 18 | 30. | The satellite is now a large <i>bright</i> round spot on the face of <i>Jupiter</i> , just within the limb.             |
| 12 | 21 | 30. | The satellite is getting fainter. I see nothing yet of the shadow. The satellite enters between two rather faint belts. |
| 12 | 24 | 30. | I only see the satellite by glimpses. I have not yet caught sight of the shadow.  |
| 12 | 29 | 6.  | I caught the first glimpse of the shadow.   |

- G.M.T.  
<sup>h</sup> <sup>m</sup> <sup>s</sup>  
 12 33 46. I obtained a glimpse of the satellite as a *light brown spot*, and about ten seconds later I should estimate the bisection of the shadow to take place; but, my attention being directed to the reappearance of the satellite, I could not precisely note the time.
- 12 35 30. The satellite is a plain *dusky* spot.
- 12 39 35. The satellite is now a *dark, irregular* spot.
- 13 5 35. The satellite is now obviously *darker* than the darkest part of either of the principal belts, is about half the diameter of the shadow, and, though more nearly round, is still of an irregular figure.
- 13 12 25. The broad belt which now covers the southern pole of *Jupiter* is adorned with a number of bright, distinct, round spots, just like so many satellites on the face, only smaller. There are at least six, and I was enabled to mark roughly the places of five of them. This is to me quite a new phenomenon. The spots are very delicate, but very round and well defined, and, though only occasionally seen, when the air is most quiet, they undoubtedly exist, and there is no illusion. The shadow of the satellite seems to have a penumbra.
- 13 43 0. The air is now becoming more disturbed.
- 13 46 0. The satellite is now half-way over, still a little oblong. Its intensity of *shade* I should estimate to be half-way between the blackness of the shadow and the darkest parts of the belts; in *size* about two-thirds the diameter of the shadow.

"During a considerable portion of these observations the air has been remarkably fine—indeed a whole year does not yield five such nights; yet, with the power and aperture employed, the image of *Jupiter* was never *still*. The presence of the atmosphere never could be forgotten; and I received this evening a strong confirmation of the opinion I have long held, that a twenty-four-inch aperture, brought to high perfection of defining power, is not far from the maximum allowed by the atmosphere of this climate to be advantageously used on objects requiring fine *definition*."

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*Extract of a Letter from Mr Lassell.*

"The times of emersion of shadow and satellite on March 5 were respectively about 7<sup>m</sup> and 5<sup>m</sup> earlier than the times in the *Nautical Almanac*, and the entry of the 4th satellite on the disc, Feb. 28, was about 8<sup>m</sup> later than the time announced.

"I took five measures of the polar diameter of *Jupiter*, Feb. 28, with my own-made micrometer =  $42''.81$ , circumstances very bad. On March 5 I took eight measures of the equatoreal diameter with the Munich micrometer =  $44''.64$ , circumstances rather better, but bad."

Mr. Lassell proposes to resume these observations when the weather is favourable.

"My equatoreal-clock does admirably. All those I know go very differently, with and without a drop of oil, and I do not know that I need say less of my own."

Mr. Hartnup says, "I saw the fourth satellite on the face of *Jupiter*, on Feb. 28. It appeared to me only a few shades lighter than the shadow. I looked at the planet, unprepared for the phenomenon, and my first impression was, that I saw the shadows of two satellites. The shadow was very large, and the diameter of it and of the satellite would have admitted of measurement had the atmosphere been favourable. The definition was very bad."

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*Proper Motions of 875 Stars of the Greenwich Catalogue of 1439 Stars, deduced by Comparison with the Places derived from Bradley's Observations, as given in the Fundamenta Astronomiæ for the Epoch 1755.* By the Rev. R. Main, M.A., of the Royal Observatory.

"One of the great objects of modern astronomy is to enable us to predict accurately the place of a given fixed star for a given epoch, and this problem the resources derived from the masses of accurate observations that are now systematically made and reduced at the great observatories of Europe enable us to solve for a tolerably large number of stars. If, in star observations at the different observatories, anything like an organised plan of division of labour had been adopted and carried out for a period of some years, we should have at the present time means of determining accurately the places of at least all the stars contained in the three great fundamental catalogues of Bradley, Piazzzi, and Groombridge, and consequently every facility for determining the proper motions of all the stars contained in those catalogues. In the instance of the last-mentioned catalogue, viz. that of Groombridge, we shall soon, through the well-directed labours of Mr. Johnson, be thus situated. He has, with an energy deserving the highest praise, very nearly completed the reobservation of all Groombridge's stars, and the formation of the catalogue containing the resulting places will form a new epoch in the sidereal astronomy of the northern heavens. But in general no systematic reobservation of the other great catalogues has been attempted, and the proper motions of stars must be deduced from the results that are found scattered in the obser-

vations, or the catalogues resulting from the observations, of the different modern observatories.

"Since the epoch of Piazzi's catalogue the most important general catalogues have emanated from Greenwich:—

"I mean, first, Pond's Greenwich catalogue of 1112 stars whose epoch is 1830.

"Secondly, Airy's Greenwich catalogue of 1439 stars whose epoch is 1840; which contains the results of all the Greenwich observations of stars from 1836 to 1841 inclusive.

"Thirdly, Airy's Greenwich catalogue of 2156 stars, which includes the results of the former catalogue (the second named), and gives additionally for the epoch 1845 the results of all the observations of stars from 1842 to 1847 inclusive.

"During the greater part of the time during which I have been engaged on the present work the last-named catalogue was not published, but I have been enabled to make use of the places given in it for completing all such results as in the second catalogue were given in only one element. The proper motions are, therefore, generally completely given in both elements, except in a few cases where there are no corresponding observations in the *Fundamenta*, or where the catalogue of 2156 stars does not contain a corresponding observation to that of Bradley.

"A glance at the Introduction of the volumes of the *Greenwich Observations* will enable us to see that the importance of the stars thus compared is much greater than their numbers would seem to warrant; for, in the first place, all the fundamental stars contained in the list of the *Nautical Almanac* have been observed with such frequency and accuracy as to render the calculation of their places an object of very great importance. In the next place, nearly all the conspicuous stars that fall in the path of the moon during a whole revolution of the node have been observed with sufficient frequency to give accurate places, so that the places given in the Greenwich catalogue, combined with the proper motions deduced by comparison with Bradley, will enable us to predict their places for nearly a century to come with amply sufficient accuracy for all the purposes of lunar astronomy. Lastly, a great many stars within the zodiacal limits have been observed for general purposes, and many that pass very near to the zenith of Greenwich, and are therefore useful for redetermination of the constants of refraction, and for geodetical purposes. In fact, few of the stars in the Greenwich catalogue have been observed without some special object that renders the determination of their places valuable. I have been induced, by the above reasons, to select the catalogue of 1439 stars for comparison with Bradley; and I hope to be able to add, from time to time, the results of the comparison of all those remaining in the catalogue of 2156 stars, and of others which may be given in future Greenwich catalogues."

Mr. Main then enters into the intricate subject of precession, and briefly explains the methods adopted by Bessel, Otto Struve, and Peters, in determining the values of the constants  $m$  and  $n$  for

every ten years between 1750 and 1850. The annual precession for each star is,

$$\text{In R.A.} = m + n \cdot \sin \alpha \cdot \tan \delta : \text{In Dec.} = n \cdot \cos \alpha.$$

“The table from which the precessions used in this paper have been computed is as follows:—

Year.	Annual General Precession.	<i>m.</i>	<i>n.</i>	Log. <i>n.</i>
1750	50'2298	46'0481	20'0650	1'302439
1760	'2320	'0509	'0642	'302421
1770	'2343	'0538	'0633	'302402
1780	'2366	'0566	'0624	'302383
1790	'2388	'0595	'0616	'302365
1800	'2411	'0623	'0607	'302346
1810	'2434	'0651	'0598	'302327
1820	'2456	'0680	'0590	'302309
1830	'2479	'0708	'0581	'302290
1840	'2502	'0737	'0572	'302271
1850	50'2524	46'0765	20'0564	1'302253

In computing the whole precessional motion, Mr. Main has adopted the formula pointed out by M. Otto Struve, viz.:—

“If  $p_1, p_2, p_3$ , be the annual precessions in R.A. or N.P.D. for a star, not very near the pole, at equidistant epochs  $t_1, t_2, t_3$ , and if the whole interval from  $t_1$  to  $t_3$  be  $T$ ,

$$\text{Then the whole precessional motion} = \frac{1}{3} (p_1 + 4 p_2 + p_3) \times T,$$

$$\text{or the mean annual precession} = \frac{1}{3} (p_1 + 4 p_2 + p_3),$$

which is generally sufficient. If four or five equidistant precessions be similarly computed,

$$\text{Mean precession} = \frac{1}{5} (p_1 + 3 p_2 + 3 p_3 + p_4), \text{ or}$$

$$= \frac{1}{50} (7 p_1 + 32 p_2 + 12 p_3 + 32 p_4 + 7 p_5)$$

respectively.”

Mr. Main then shows how, by taking advantage of the nearness of his epochs to equidistance, he has been enabled to avail himself of Bessel's precessions for 1755 and 1800, after applying certain corrections which he has tabulated under a very convenient form:—

“For a few stars near the pole the whole precessional motion was computed rigorously by Bessel's method, given in the *Fundamenta* and the *Tabula Regiomontanae*, by means of the numbers given by Mr. Baily in the Introduction to the *Catalogue of the British Association*. Suitable corrections were applied to reduce the resulting mean annual precession to that which would have been obtained by using Peters' constants.”

The results of Mr. Main's investigations are arranged in three catalogues.

First, a list of 875 stars, with the proper nomenclature and the

numbers of the *Fundamenta* affixed, of which the proper motion has been determined by a comparison between the *Fundamenta* and the *Greenwich Catalogue of 1439 Stars*, using Peters' precession. There are four columns to each element, which are respectively the correction to Bessel's precession, the mean precessional motion according to O. Struve's and Peters' determination, the mean annual motion as deduced from a comparison of the two catalogues, and, lastly, the proper motion or difference between the two preceding columns.

Secondly, a catalogue of stars selected from the previous catalogue, which have proper motions greater than  $0^{\circ}.005$  in R.A. or  $0^{\circ}.1$  in N.P.D. To this catalogue, which contains nearly 370 stars, the approximate R.A. and N.P.D. of the stars are added, as well as Argelander's magnitudes and the number of observations.

Thirdly, a catalogue of those stars in the first list which have proper motions exceeding  $0^{\circ}.02$  in R.A. and at least  $0^{\circ}.3$  in N.P.D. These are 85 in number, including double stars: and Mr. Main has appended two new columns, containing the factors of the effect of solar motion upon each star in R.A. and N.P.D., supposing the motion to be  $= 1$ , and directed to a point in the heavens which is in R.A.  $260^{\circ}$  and N.P.D.  $55^{\circ} 37'$ . Mr. Main considers this motion, first pointed out by Sir W. Herschel and since established by the investigations of Argelander, O. Struve, and Galloway, to be quite certain, and that the direction is pretty well fixed. The quantity of the solar motion, as detected by O. Struve, is less certain, but yet a fair approximation, which may perhaps be improved by taking the results of the present memoir into consideration.

The errors introduced into the catalogue of the *Fundamenta* by Lindenau's value of the constant of nutation, now generally considered erroneous, cannot be *completely* eliminated, except by reducing the observations anew, or by a careful rectification of Bessel's MSS. computations.

"With regard to double stars I have been guided by their closeness and the probable nature of Bradley's observations. If one star of a tolerably close double star is considerably brighter than the other, I have compared Bradley's observation with the Greenwich observation of the larger star. If the stars be close and tolerably equal in magnitude, I have compared Bradley's observations with the mean of the Greenwich observations for both stars, if both have been observed. I have, in every case, given due attention to the nature of the observations.

"I hope the results of this comparison of the Greenwich catalogue with that of Bradley, by means of the best known modern data, will be acceptable to astronomers, at least as a basis for future operations. Before we can hope to improve greatly our present sidereal knowledge, it will be necessary that this labour be undertaken for all the stars of the catalogues of Bradley and Piazzi; and, for this purpose especially, that pains be taken in our principal observatories that such stars in those catalogues as have

not been recently observed should be so as speedily as possible, and with sufficient frequency to give places of indisputable accuracy.

"In the mean time the recently published Greenwich twelve years' catalogue will still further assist our inquiries; and I hope, at no distant time, to be able to offer to the Society the result of the comparison of all the stars common to it and the *Fundamenta* which are not already included in the present memoir."

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*Extract of a Letter from Mr. J. Curley, of Georgetown College, Washington.*

"On the 28th November last, the Rev. T. M. Jenkins, a member of this College (to whose liberality we are indebted for our observatory), when on his passage to Rio Janeiro, saw a comet, of which the following is a description.

"On the 28th of November, at  $7^{\text{h}}\frac{1}{4}$  p.m." (being then in about  $10^{\circ}$  S. latitude, and  $30^{\circ}$  W. longitude), "we saw a comet to the westward, nearly in the track of the sun, about  $14^{\circ}$  above the horizon, as measured with the quadrant. The nucleus very distinct, about as large in appearance as *Mars*, the tail curved and pointing towards the south (SW.), quite bright and nearly a degree in length as seen by the naked eye, but much larger when viewed with the glass. It was seen by all the crew for about twenty minutes, when a cloud obscured it and it was seen no more."

Mr. Curley suggests the probable identity of this comet with the great comet of 1556, to which Mr. Hind has drawn attention. Mr. Hind remarks on Mr. Curley's letter,—“I think it is *quite possible* that the comet seen by the Rev. T. Jenkins on November 28, 1849, may have been the great one expected about that time. My own opinion, however, though I must admit the possibility of the identity, is, that the object observed was not the expected comet. If we are to understand by ‘the track of the sun,’ the *same parallel of declination*, the right ascension of the comet would have been about  $18^{\text{h}} 30^{\text{m}}$ , giving the time of perihelion passage, with my elements, about Nov. 13, 1849, but on this supposition the comet's declination would be rather less than that of the sun, which seems to be contradicted by the direction of the tail. Again, if we suppose the two comets identical, and perihelion passage November 13, it is not very easy to account for its not having been observed after the 28th of that month, since it would be receding from the sun's place, though at the same time going away from us.

"I do not think it is practicable to observe the comet now, if it were in perihelion between November 10 and 20, 1849. I find, if we fix the perihelion passage on November 10, the comet's position, April 1, will be about,

Right Ascension,  $2^{\text{h}} 21^{\text{m}}.3$ . North Polar Distance,  $92^{\circ} 39'$ .

Distance from earth,  $3'40$

„ sun,  $2'56$

"And if we suppose perihelion passage November 20, we have for April 1,—

Right Ascension,  $2^h 14^m 9^s$ . North Polar Distance,  $92^\circ 26'$ .

Distance from earth,  $3.27$

„ sun,  $2.42$

"The comet must, therefore, be situate in strong twilight; but, perhaps Mr. Lassell, Mr. Hartnup, or Professor Challis, may think it worth while to look at the neighbourhood. I am prevented here by trees."

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*On the Expected Comet of 1264 and 1556.* By Mr. Hind.\*

"Mr. Barber, who was recently elected a Fellow of the Royal Astronomical Society, and who undertook to continue the calculation of the perturbations of the comet of 1556, which I had commenced in 1848, has just sent me a notification of one of his results, which appears to show that the comet may not be due for some time to come; at any rate, it renders a close and systematic research very desirable. Mr. Barber finds that the effect of the attraction of *Jupiter*, *Saturn*, and *Uranus*, from 1556 to 1592, and of *Jupiter* alone to 1806 (including the aphelion portion of the orbit), will *retard* the comet no less than 750 days; and there can, I think, be very little doubt that *Saturn* and *Uranus* will delay it still longer.

"Mr. Barber is computing the disturbances produced by *Saturn* up to 1806, but has not yet completed them. The 750 days added to the time of arrival at perihelion, supposing *T* unaltered, brings us up to April; but even this must be too early, if the major-axis in 1556 corresponded to the periodic time from 1264 to 1556; and I think there is as much reason to suppose it longer as shorter than the value thus found.

"My object in writing to you is to apprise you of Mr. Barber's results, in case you think there are other observers, with telescopes of sufficient power, who would be willing to look out for the comet. I find it is most convenient to project the calculated places on a chart: it is then easy to see in what *line* the comet should be sought, on any particular date, according to different hypotheses respecting the time of arrival at perihelion.

"I think what is most wanted is an ephemeris for distances of (say) 140 or 150 days from perihelion passage, for at this time of the year the part of the heavens where the comet is to be sought will be near opposition.

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\* As the *Notice* is going to press, Mr. Hind informs me that he has reason to believe the return of this comet may be delayed by perturbation *for some years*. I have therefore suppressed the *sweeping* ephemerides which he had computed on the supposition that the perihelion passage of the planet might be expected next autumn. A further account of this comet may be expected from Mr. Hind very shortly.—*Ed. M. N.*

"In a day or two I will send you positions for April, on the supposition that the comet will arrive at perihelion in August, September, and October. I had, for the sake of convenience, laid down the places on a chart, which is much the best plan for practical purposes, but any one may do this when they are furnished with the computed positions.

"My ephemeris I will send as soon as possible. Mr. Barber has worked very hard on this comet, and has been compelled to use various artifices to shorten the work, some of which I believe to be new. Thus, at the aphelion, he has proceeded by equal intervals of *true* anomaly, and one or two changes have been made in the usual application of the formulæ of integration. I will ask him to send you an account of his work, as it is right the trouble he has taken should be appreciated.

"By far the largest perturbations occur at great distances from the sun. I knew this had happened in the case of Halley's comet, which was my reason for supposing that the comet of 1556 would furnish another instance, since the *cause* must be more powerful in the latter case."

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*Note from M. O. Struve to G. B. Airy, Esq. Astronomer Royal, and President of the Royal Astronomical Society.*

"To my note on the parallax of Groombridge, 1830, I must make an addition. I have found a third system of equations, in which the conditions of the systems I. and II. have been combined as well as possible. The resolution of the new equations has given the following results:—

The parallax ..... =  $+0^{\circ}.034$  with the probable error  $0^{\circ}.029$

The proper motion in declination  $-5^{\circ}.748$  ———  $0^{\circ}.024$

These values must be regarded as the definitive result of my research.

"1850, Jan. 3."

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*Extract of a Letter from Mr. Lowe on Zodiacal Light, as seen at Highfield House, near Nottingham.*

"As some curious features have been noticed in the '*Western Light*,' whether it be the zodiacal light or another phenomenon, a brief extract from my journal has been thought to be acceptable.

Epoch 1850, February 13<sup>d</sup> 7<sup>h</sup> 30<sup>m</sup>.

"The zodiacal light was certainly more brilliant to-night than it has been for the last seven years (*i.e.* as far as my observations extend); it exceeded the brightness of the milky way about the *Swan*, which was the part compared with it. *Saturn* was about  $2^{\circ}$  within its southern edge, and its apex must have had an altitude equal to that of the *Pleiades*. Unfortunately clouds came over before any bearings were made. *Saturn* was thought to be dimmed by it.

Epoch 1850, March 6<sup>d</sup> 7<sup>h</sup> 42<sup>m</sup>.

"Extent of base on horizon, 36°; its southern edge cut the horizon 13° S. of W., and its northern edge 23° N. of W.; long. of apex 8 21° 30' when at its brightest, yet at times only visible to 8 17°; axis slightly N. of *Pleiades*, and the horizon 5° N. of W. The S. edge somewhat confused, but appeared to pass through  $\xi$  *Ceti*,  $\alpha$  *Ceti* about 2° within the edge; the N. edge was better defined, and was tolerably bold about  $\gamma$  *Arietis*; it passed through  $\epsilon$  *Piscium*, between  $\gamma$  and  $\beta$  *Arietis* (about midway), and 1° S. of  $\delta$  *Arietis*. Not nearly so brilliant as on February 13<sup>d</sup>, but appears to have pulsations of greater and less brilliancy in periods of 30°. This was first noticed by several small stars being alternately visible and invisible; it was not changeable like aurora borealis, for it invariably receded to a certain dimness, and then brightened to a certain extent.

Epoch 1850, March 7<sup>d</sup> 8<sup>h</sup> 0<sup>m</sup>.

"The N. edge certainly extended to  $\beta$  *Arietis*. Pulsations of greater and less brilliancy again noticeable.

Epoch 1850, March 8<sup>d</sup> 7<sup>h</sup> 15<sup>m</sup>.

"Pale and confused. Stars dim.

Epoch 1850, March 9<sup>d</sup> 7<sup>h</sup> 55<sup>m</sup>.

"Brilliant for a few minutes, during which time the alternating of brightness was observed.

Epoch 1850, March 10<sup>d</sup> 7<sup>h</sup> 50<sup>m</sup>.

"Brilliant for 7<sup>m</sup>; then clouds. Its N. edge was thought to extend to  $\alpha$  *Arietis*. Strong pulsations; brighter than last night.

Epoch 1850, March 11<sup>d</sup> 7<sup>h</sup> 59<sup>m</sup>.

"Fainter. The apex reached  $\xi$  *Arietis*. The S. edge passed just to the north of  $\mu$  *Ceti*,  $\xi$  *Ceti* about 2° within the edge; the N. edge half-way between  $\alpha$  and  $\beta$  *Arietis*. Faint pulsations.

Epoch 1850, March 12<sup>d</sup> 8<sup>h</sup>.

"Fainter. S. edge confused; N. edge passed between  $\alpha$  and  $\beta$  *Arietis*, but slightly nearer  $\beta$  than half-way. Apex reached  $\xi$  *Arietis*.

Epoch 1850, March 13<sup>d</sup> 8<sup>h</sup>.

"Yet fainter. N. edge passed between  $\alpha$  and  $\beta$  *Arietis*, yet still nearer  $\beta$  than last night. Apex reached  $\xi$  *Arietis*.

"Clouds or moonlight prevented the phenomenon being noticed between February 13<sup>d</sup> and March 6<sup>d</sup>, and from March 13<sup>d</sup> to 23<sup>d</sup> (present time). I had seen it, and noted down bright zodiacal light, from the middle of January; and it appears to have been increasing in brilliancy up to the time we lost sight of it first, viz. February 13<sup>d</sup>. During its second appearance it has been gradually fading. The stars  $\alpha$ ,  $\beta$ , and  $\gamma$  *Arietis* were well situated for marking

By C. Rümker.

1850.	Hamburg M.T.	App. R.A.	App. Decl.	
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>o</sup> <sup>'</sup> <sup>"</sup>	<sup>o</sup> <sup>'</sup> <sup>"</sup>	Equatoreal.
Feb. 22	11 41 57.6	201 55 2.6	+ 6 32 36.3	—
Mar. 8	16 37 22.1	200 34 56.1	8 42 51.2	—
9	10 25 37.5	28 51.4	8 49 57.9	—
11	9 30 40.4	200 12 2.6	9 8 57.5	—
15	10 35 6.2	199 33 47.6	9 48 2.3	—
30	8 20 15.3	196 42 1.0	12 4 42.1	—
31	8 45 59.5	29 4.7	13 13.8	—
April 1	8 18 44.0	196 16 32.1	21 10.1	—
3	9 58 54.0	195 50 5.3	12 37 30.4	—
8	10 47 52.0	194 45 9.1	13 14 16.9	—
11	9 52 15.1	194 7 20.5	33 25.5	—
15	10 31 34.5	193 17 14.5	13 56 25.7	—
16	10 27 43.9	193 5 7.8	14 1 33.6	—
17	9 6 47.4	192 53 46.5	6 16.6	—
17	11 8 45.4	52 40.9	6 38.2	Mer. Circle.
18	11 4 2.5	40 55.9	11 20.7	—
19	10 59 21.8	192 29 38.4	+ 14 15 55.7	—

The position of *Hebe*, April 1, rests on a transit of the planet over a fixed star, the light of the latter eclipsing that of the planet so completely, that their places may be considered very nearly as identical.

*Mean Places for January 1, 1850, of Stars in the Orbit of Hebe, deduced from Observations with the Meridian Circle.*

Mag.	Mean R.A.	Mean Dec.	Day of Comparison with Hebe.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>o</sup> <sup>'</sup> <sup>"</sup>	
7.8	12 40 19.425	+ 14 14 37.9	
7	12 40 43.366	14 22 22.6	
8	12 45 51.560	14 9 31.3	
7	12 53 55.516	13 58 36.9	} April 11, 15, 16, 17
9	12 54 13.797	13 58 59.3	
9	13 0 0.238	13 7 44.0	} April 8
9	13 0 5.817	13 4 32.1	
9	13 0 37.024	12 59 58.1	
7	13 5 4.898	12 21 16.6	April 1 and 3
7	13 7 2.245	12 7 44.2	March 30, 31
9	13 12 25.939	11 16 40.6	
9	13 18 54.318	9 41 25.9	March 15
9	13 23 54.101	8 49 49.1	March 9
7	13 25 35.916	+ 6 37 24.7	Feb. 22

## HYGEIA.

MARKREE.

Equatoreal.

(E. J. Cooper, Esq.,  
and A. Graham.)

1850.	Greenwich M.T.			R.A.			N.P.D.			Stars of Comparison.	Relative Weights.
	h	m	s	h	m	s	°	'	"		
May 26	11	17	18.9	12	2	24.84	95	30	3.7	a	12
29	11	49	25.6	3	12	84	29	52	6	a	30
31	12	6	2.2	3	51	25	30	42	0	a	30
June 5	11	53	48.9	5	47	13	34	59	2	a	12
6	11	5	50.8	6	12	07	36	3	8	a	20
7	10	55	58.8	6	39	78	37	28	1	b	20
8	11	1	23.6	7	8	74	38	45	1	b	15
9	11	45	22.3	7	40	65	40	34	2	c	12
12	11	5	26.4	12	9	15.52	95	45	53.9	d	20

Corrected for Parallax.

Mean Places of stars, 1849.0.

	h	m	s	°	'	"	
a	12	3	23.87	95	42	37.9	Weisse 35
b	12	6	54.22	95	50	25.1	" 100
c	12	10	10.03	95	35	16.4	" 153
d	12	10	59.23	95	40	4.4	" 168

May 31. Very faint.

June 5. Excessively difficult. Strong moonlight.

7. Observation not good.

BERLIN.

(Prof. Encke and Dr. Galle.)

1850.	Berlin M.T.			R.A.			Dec.		
	h	m	s	°	'	"	°	'	"
Mar. 14	16	46	18	284	22	7.1	-24	16	
15	16	53	4	284	41	19.1	-24	14	
17	16	44	38	285	18	49.0	-24	8	

*Extract of a Letter from M. d'Arrest to Sir J. F. W. Herschel,  
Bart.*

"The new planet *Hygeia* having been found again by Dr. Galle on the 14th of March, emerging from the morning twilight as a star of the 12th magnitude, I have applied corrections to the orbit, insufficiently known by the observations of the first period of visibility.

"I therefore take the liberty to present to you, by this letter, my elements No. V., together with an ephemeris, which may perhaps prove useful to English observers, no other computations having been published, as I believe, relating to this planet. The ephemeris I have given in Encke's *Year-Book* for 1852 is to be laid aside, as based on my elements No. II."

*Elements of Hygeia, No. V.*1849, April 15, <sup>0</sup><sub>h</sub>, Berlin M.T.

Mean longitude .....	198 7 34.98	} Mean Equinox, 1849, Jan. 0.
Long. of perihelion .....	226 39 53.89	
Long. of the asc. node ...	287 55 39.11	
Inclination .....	3 46 59.12	
Angle of eccentricity .....	5 23 22.64	
Log. <i>a</i> .....	0.4944079	
Eccentricity .....	0.0939280	
Mean daily motion .....	643".2723	(sider.)
Sider. period .....	2014.7	Mean solar days.

*Ephemeris of Hygeia, for Berlin Mean Midnight.*

	R.A.	Decl.	Log. Dist.	Log. <i>r</i> .
April 2	289 45 56.0	-23 33 50.4	0.44772	0.46089
4	290 15 40.7	23 29 15.2	0.44369	
6	290 44 25.6	23 24 41.2	0.43962	0.46126
8	291 12 9.4	23 20 8.4	0.43551	
10	291 38 49.9	23 15 38.4	0.43136	0.46163
12	292 4 25.4	23 11 12.0	0.42717	
14	292 28 54.0	23 6 50.1	0.42295	0.46200
16	292 52 14.3	23 2 32.6	0.41870	
18	293 14 24.1	22 58 19.8	0.41442	0.46239
20	293 35 24.1	22 54 12.1	0.41012	
22	293 55 13.8	22 50 12.0	0.40580	0.46278
24	294 18 50.2	22 46 18.3	0.40146	
26	294 31 9.7	22 42 32.1	0.39712	0.46317
28	294 47 13.3	22 38 54.1	0.39276	
30	295 1 59.8	22 35 24.6	0.38839	0.46357
May 2	295 15 26.7	22 32 4.3	0.38402	
4	295 27 32.3	22 28 54.0	0.37966	0.46397
6	295 38 15.2	22 25 54.0	0.37531	
8	295 47 33.3	22 23 4.7	0.37097	0.46438
10	295 55 26.0	22 20 26.4	0.36666	
12	296 1 51.8	22 17 59.4	0.36238	0.46479
14	296 6 50.3	22 15 44.3	0.35813	
16	296 10 20.9	22 13 40.7	0.35393	0.46521
18	296 12 23.3	22 11 49.0	0.34979	
20	296 12 56.6	22 10 9.5	0.34570	0.46563
22	296 12 0.8	22 8 42.1	0.34167	
24	296 9 35.9	22 7 26.7	0.33772	0.46606
26	296 5 41.9	22 6 23.5	0.33386	
28	296 0 18.6	22 5 31.8	0.33010	0.46649
30	295 53 25.8	-22 4 51.5	0.32643	

# Neptune.

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		R.A.	Decl.	Log. Dist.	Log. r.
June	1	295 45 4'3	-22 4 22'2	0'32287	0'46693
	3	295 35 15'6	22 4 4'2	0'31943	
	5	295 24 1'9	22 3 56'2	0'31613	0'46737
	7	295 11 24'3	22 3 58'5	0'31297	
	9	294 57 25'5	22 4 10'3	0'30994	0'46781
	11	294 42 6'8	22 4 30'5	0'30708	
	13	294 25 31'6	22 4 58'3	0'30441	0'46826
	15	294 7 44'2	22 5 33'1	0'30192	
	17	293 48 49'3	22 6 13'9	0'29960	0'46871
	19	293 28 51'2	22 6 59'7	0'29748	
	21	293 7 53'2	22 7 50'0	0'29555	0'46916
	23	292 45 58'9	22 8 43'3	0'29384	
	25	292 23 14'2	22 9 39'5	0'29235	0'46962
	27	291 59 45'0	22 10 37'4	0'29108	
	29	291 35 38'4	22 11 36'0	0'29005	0'47008
July	1	291 10 57'8	22 12 34'3	0'28926	
	3	290 45 49'9	22 13 31'5	0'28871	0'47055
	5	290 20 21'9	22 14 26'8	0'28840	
	7	289 54 41'0	22 15 19'5	0'28833	0'47102
	9	289 28 52'0	22 16 8'9	0'28851	
	11	289 3 2'1	22 16 54'5	0'28893	0'47149
	13	288 37 21'0	22 17 35'8	0'28960	
	15	288 11 55'3	22 18 11'7	0'29051	0'47197
	17	287 46 50'6	22 18 41'7	0'29167	
	19	287 22 13'9	22 19 6'2	0'29306	0'47244
	21	286 48 10'0	22 19 24'6	0'29469	
	23	286 24 45'8	22 19 37'0	0'29655	0'47292
	25	286 2 6'6	22 19 42'8	0'29863	
	27	285 50 18'9	22 19 42'2	0'30092	0'47341
	29	285 29 28'4	22 19 35'1	0'30342	
	31	285 9 41'1	-22 19 21'7	0'30611	0'47390

Reckoned from the apparent equinox.

## NEPTUNE.

MARKREE.		Meridian Circle.		(E. J. Cooper, Esq., and A. Graham.)	
1840.	Greenwich M.T.	R.A.	N.P.D.	No. of Wires.	
	h m s	h m s			
Oct. 13	9 22 41'3	22 18 8'26	101 20 58'1	7	
29	8 19 2'5	17 23'84	25 1'2	7	
30	15 4'8	17 22'03	25 10'5	7	
Nov. 2	8 3 12'2	17 17'15	25 34'0	7	
13	7 19 49'8	17 9'77	26 5'8	7	
Dec. 4	5 57 45'0	22 17 39'11	101 23 3'0	7	

Corrected for parallax.

*Lassell's Satellite of Neptune.*

Observations by Mr. Lassell, with the 20-foot Equatoreal Reflector,  
Power 366.

	Greenwich M.T.	Position.	Distance.	Obs.
1849.	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup>	<sup>"</sup>	
Nov. 15	6 56 40.7		17.45	4
	7 34 58.0	219 57		5
Dec. 6	6 35 25.7	45 2		5

Nov. 15. Measures of distance difficult.

Dec. 6. Sky brilliant, but definition bad; no satisfactory measure of distance could be taken.

## ASTRÆA.

## LIVERPOOL.

## Equatoreal.

(Mr. Hartnup.)

	Greenwich M.T.	R.A.	N.P.D.	Stars of Comp.
1850.	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>	
March 16	8 4 23.8	3 58 29.94	73 35 25.9	γ Tauri
	8 34 17.1	32.06	14.1	—
18	8 39 42.2	4 1 52.05	73 21 35.7	δ Tauri
	9 9 40.6	54.22	26.4	—

The observations are corrected for refraction and parallax. The following assumed places of the stars of comparison are derived from the *Greenwich Observations*.

For January 1, 1850.

	Mean R.A.	Mean N.P.D.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
γ Tauri	4 11 15.71	74 44 21.14
δ Tauri	4 14 17.35	72 48 50.45

## METIS.

## MARKREE.

## Equatoreal.

(E. J. Cooper, Esq., and  
A. Graham.)

	Greenwich M.T.	R.A.	N.P.D.	Stars of Comparison.	Relative Weights.
1849.	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>		
June 19	14 7 36.1	22 39 22.60	105 37 52.7	a, b, c	18
26	13 32 28.6	22 42 20.77	105 45 8.5	d	15
July 11	13 19 19.0	22 44 42.24	106 26 8.9	e	20
12	13 18 24.5	22 44 39.00	106 30 6.1	e	40
Sept. 6	11 56 0.3	22 5 47.36	111 45 44.0	f	30
1850.					
Jan. 15	6 42 12.5	23 28 41.99	97 42 1.4	g	30
16	6 51 49.4	23 30 19.09	97 29 41.4	h	20

Mean Places of stars, 1849<sup>o</sup>

<i>a</i>	<sup>h</sup> 22 <sup>m</sup> 36 <sup>s</sup> 14 <sup>o</sup> 60	<sup>h</sup> 105 <sup>m</sup> 24 <sup>s</sup> 8 <sup>o</sup> 4	Merid. Circle, 1 Obs.
<i>b</i>	22 36 18 <sup>o</sup> 72	105 27 57 <sup>o</sup> 4	" 1
<i>c</i>	22 36 55 <sup>o</sup> 15	105 35 28 <sup>o</sup> 3	" 1
<i>d</i>	22 42 31 <sup>o</sup> 92	105 31 45 <sup>o</sup> 1	" 2
<i>e</i>	22 46 37 <sup>o</sup> 91	106 37 20 <sup>o</sup> 0	B.A.C. 7980
<i>f</i>	22 5 57 <sup>o</sup> 28	111 49 21 <sup>o</sup> 6	B.A.C. 7751. Took this.
	57 <sup>o</sup> 03	20 <sup>o</sup> 5	Merid. Circle, 5 Obs.

Mean Places of stars, 1850<sup>o</sup>

<i>g</i>	23 28 33 <sup>o</sup> 91	97 56 47 <sup>o</sup> 0	Weisse 592
<i>h</i>	23 33 26 <sup>o</sup> 35	97 18 32 <sup>o</sup> 3	Weisse 693

## Meridian Circle.

1849.		Greenwich M.T.	R. A.	N.P.D.	No. of Wires.
		<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>o</sup> <sup>'</sup> <sup>"</sup>	
Aug.	3	14 19 57 <sup>o</sup> 6	22 36 16 <sup>o</sup> 09	108 31 24 <sup>o</sup> 2	5
Sept.	3	11 50 23 <sup>o</sup> 4	8 32 <sup>o</sup> 91	111 34 29 <sup>o</sup> 3	7
	4	45 32 <sup>o</sup> 0	7 36 <sup>o</sup> 89	38 25 <sup>o</sup> 1	6
	5	41 8 <sup>o</sup> 3	6 41 <sup>o</sup> 97	42 12 <sup>o</sup> 6	2
	7	31 1 <sup>o</sup> 9	4 54 <sup>o</sup> 07	111 49 10 <sup>o</sup> 9	7
	11	11 11 54 <sup>o</sup> 3	22 1 29 <sup>o</sup> 58	112 0 33 <sup>o</sup> 8	7
	14	10 57 45 <sup>o</sup> 6	21 59 8 <sup>o</sup> 14	6 55 <sup>o</sup> 4	7
	17	43 43 <sup>o</sup> 7	56 59 <sup>o</sup> 02	11 16 <sup>o</sup> 0	6
	18	39 12 <sup>o</sup> 9	56 18 <sup>o</sup> 63	12 23 <sup>o</sup> 5	7
	19	34 38 <sup>o</sup> 1	55 39 <sup>o</sup> 67	13 12 <sup>o</sup> 7	7
	20	10 30 5 <sup>o</sup> 2	55 2 <sup>o</sup> 55	13 57 <sup>o</sup> 7	7
Oct.	1	9 41 55 <sup>o</sup> 6	50 7 <sup>o</sup> 09	112 7 16 <sup>o</sup> 5	7
	5	25 19 <sup>o</sup> 0	49 13 <sup>o</sup> 96	111 59 3 <sup>o</sup> 3	7
	8	13 10 <sup>o</sup> 9	48 53 <sup>o</sup> 54	50 58 <sup>o</sup> 7	7
	10	9 5 14 <sup>o</sup> 7	48 49 <sup>o</sup> 13	111 44 45 <sup>o</sup> 2	7
	29	7 55 47 <sup>o</sup> 3	54 4 <sup>o</sup> 88	110 14 52 <sup>o</sup> 6	7
	30	52 24 <sup>o</sup> 6	54 38 <sup>o</sup> 11	110 8 48 <sup>o</sup> 1	7
Nov.	2	42 7 <sup>o</sup> 2	21 56 26 <sup>o</sup> 53	109 49 50 <sup>o</sup> 2	3
	13	7 7 34 <sup>o</sup> 3	22 4 52 <sup>o</sup> 28	108 31 27 <sup>o</sup> 4	7
	23	6 38 2 <sup>o</sup> 1	14 40 <sup>o</sup> 75	107 9 24 <sup>o</sup> 6	7
	24	35 10 <sup>o</sup> 7	15 45 <sup>o</sup> 44	107 0 40 <sup>o</sup> 1	7
Dec.	4	6 7 27 <sup>o</sup> 8	22 27 23 <sup>o</sup> 55	105 28 42 <sup>o</sup> 8	5

August 3. Very faint. Bisection not good.

Sept. 17. This observation cannot be depended on. Wires too strongly illuminated.

Oct. 5. Horizontal wires not distinct. Transits well taken.

10. Extremely faint. The transits were little better than guesses.

29. Extremely faint.

30. Extremely faint.

Nov. 2. Extremely faint. Little better than guesses.

13. Faint, but well taken.

23. Extremely faint.

24. Very faint.

Dec. 4. Extremely faint.

All these places are corrected for parallax.

## IRIS.

LIVERPOOL.	Greenwich M.T.	Equatoreal.	(Mr. Hartnup.)	
	h m s	R.A. h m s	N.P.D. ° ' "	Star of Comp.
1850. May 1	12 31 5 <sup>o</sup>	15 47 26 <sup>h</sup> 83	113 41 4 <sup>h</sup> 5	<i>a</i>
	13 10 58 <sup>o</sup>	15 47 25 <sup>h</sup> 26	113 41 2 <sup>h</sup> 6	<i>b</i>

"The observations are corrected for refraction and parallax. The following are the assumed *apparent* places of the stars of comparison.

	R.A. h m s	N.P.D. ° ' "
<i>a</i>	15 45 2 <sup>h</sup> 68	113 31 31 <sup>h</sup> 1
<i>b</i>	15 41 59 <sup>h</sup> 81	115 17 24 <sup>h</sup> 9

"The mean place of *a* was taken from the *Greenwich Twelve-year Catalogue*, and of *b* from the B.A.C.

"The planet appeared to me to shine as a star of about the 9<sup>th</sup> magnitude."

*Sketch of Jupiter, as seen on the 27th March, 1850, at 11<sup>h</sup> 11<sup>m</sup> 0 G.M.T. By Mr. Lassell. With his 20-foot Equatoreal Reflector, 24 inches' aperture, power 430.*



"In this sketch I have attempted to delineate the phenomena of the disk of *Jupiter*, seen with the 20-foot equatoreal, power 430, 24 inches' aperture. The *white spots* are most remarkable.\* The principal spot is exactly half way over at 11<sup>h</sup> 0. They are all perfectly round, distinct, and bright. The largest is as plain as I have seen with the 9-foot, the disk of a satellite just entered within the limb, and as well defined. They are striking phenomena.

"11<sup>h</sup> 20<sup>m</sup>. The spots keep their relative positions, as they are carried along by *Jupiter's* rotation; and there are no other similar spots anywhere on the disk. I tried 22 and 20 inches' aperture, but there was no improvement of definition."

*Extract of a Letter from Mr. Norman Pogson.*

"No orbit has, I believe, yet been computed of the comet of Pons, observed at Marseilles in 1818: indeed, the four observations

\* A wood-cut cannot render the shading of *Jupiter's* body satisfactorily, but the position and approximate size and appearance of the *white spots* give a fair idea of Mr. Lassell's sketch. After the evening meeting, Mr. Dawes said that he had seen the same appearance, which bears some resemblance, at first sight, to the craters in the moon.

taken were not very tempting ones for such a purpose. Mr. Hind has, however, deduced three places from them. They are as below :—

	Berlin M.T.	R.A.	Decl.
1818. Feb. 23	3 12	31 12	—15 12
	25 312	34 43	16 43
	27 312	38 14	—18 16

“From *these* places, as a first approximation, I have observed the following elements :—

T	Feb. 7.434	Berlin M. T.
$\Omega$	250° 4' 0	
$\varpi$	95 7' 0	
I.	20 2' 4	
Log. $q$	9.86526	Motion direct.

“As the original observations were involved in a little mystery from some supposed errors, Mr. Hind says he will enter more fully on the subject, when the *corrected* elements are finished, which shall be as early as I can possibly find time for. The elements are almost identical with those of a comet which appeared in 1772, supposed to have been the comet of Biela. Probably it will prove an apparition of that body. I will work out two orbits, and take the mean, as there are four observations.”

*Bright Satellites of Uranus. (Nos. II. and IV. of Herschel.)*

Observations by Mr. Lassell, with the 20-foot Equatoreal Reflector.

		Greenwich M.T.	Position.	Distance.	Obs.
1840.		<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>o</sup> <sup>'</sup>		
Nov. 15	IV.	11 13 30.5	3 29		3
	IV.	58 52.3		45.24	3
	II.	11 26 1.5	293 32		3
	II.	51 52.2		23.50	3

*Occultations of Stars by the Moon observed at Ashurst*  
(51° 15' 58" N. lat., 0<sup>h</sup> 1<sup>m</sup> 10<sup>s</sup> W. long.) By Mr. Snow.

		Ashurst M.T.		
		<sup>h</sup> <sup>m</sup> <sup>s</sup>		
1839.				
Dec. 3	33 Ceti	Imm. 4 58 12.0	Dark L.	not certain.
27	1526 B.A.C.	Imm. 4 56 58.3	Dark L.	very good.
1850.				
Mar. 27	$\gamma$ Virginis, 1st star	Imm. 12 49 47.5	Bright L.	
	2d star	Imm. 51.5	—	contact.
		— 52.5	—	disappearance.
	Both stars	Em. 14 0 5.5	2d L.	
	The stars emerged simultaneously.*			

\* Mr. Snow gives a diagram of the occultation, and states the angle of position of the double star to be, roughly, 177°.5, and the distance about 3".

“Both of the stars composing the double star  $\gamma$  Virginis, at immersion as well as at emersion, disappeared and reappeared slowly, like planetary bodies. In the case of the first star (the one of the two components that first reached the moon's limb), I am not sure whether I noted down its first contact or its final disappearance. But, as also was the case with its companion star, it occupied about 1<sup>s</sup>, or a little longer, in disappearing: not that the stars merely *clung* to the moon's limb, and then suddenly disappeared, but they disappeared *gradually*; and at one instant were seen fairly dichotomised, just as would have been the case with a planetary disk. In the case of the second star, both its first contact with the moon's limb, as well as its final disappearance, was noted, as above, and presented phenomena of *gradual disappearance*, precisely similar to those presented by the first star. Beyond this, neither star, at immersion or at emersion, was seen to suffer the slightest change either of colour or magnitude; and the absolute equality of the two components was throughout very striking. The instrument used was the 5-foot equatoreal, with clock-work movement, &c. The power employed was 245, which separated the stars very beautifully: so fine was the night, that with this power the limb of the full moon was singularly well defined and steady. The stars emerged nearly together, the line joining their centres being nearly a tangent to the moon's limb; and they reappeared in *contact* with the edge of the *illuminated* portion of the disk. The moon had passed her full, though only by 2<sup>h</sup>. The night was frosty, perfectly serene and calm, with admirable definition; and every circumstance as favourable as possible during this most interesting occultation.

“I was carefully on the watch on the 15th and 16th of April for the occultations of *Aldebaran* and of 119 and 120 *Tauri*, but was completely baffled by the bad weather.”

*Observations of  $\gamma$  Virginis.* By Mr. Hartnup, with the Liverpool 8½-inch Equatoreal Achromatic.

Parallel Wire Micrometer; Power 288.

Epoch.	Position.	Weight.	Distance.	Weight.	No. Obs.
1850·299	177 9	6	2·82	6	10
1850·302	176 8	3	3·02	3	10
1850·310	175 53	6	2·94	6	10
1850·304	176 26	15	2·91	15	30

Double-image Micrometer; Power 261.

1850·292	178 13	4	2·80	4	10
1850·299	178 57	5	2·91	5	10
1850·302	178 33	3	2·93	3	10
1850·298	178 36	12	2·88	12	30

"I got my zero for angles of position with the divided eye-piece from a mean of several stars. This agrees very nearly with the zero from  $\gamma$  *Virginia*. An observation with the divided eye-glass is the mean of two readings, either in position or distance, taken in contrary separation of the images. The weights are estimations depending on the perception of the observer, the fineness of the night, the consciousness of being successful or not," &c.

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*Extract of a Letter from Prof. Weisse to Col. Sabine, relating to the Continuation of the Reduction of the Observations of the Stars in Bessel's Zones.*

"On astronomy I cannot say much; the sky has been throughout the past winter very unfavourable for observations; weeks were frequently passed without a star being seen. You are aware that I have determined to work up the remaining zones of Bessel from  $+15^{\circ}$  to  $+45^{\circ}$ . This is a very laborious work, which requires much time and an enormous amount of patience, all the more that I am confined to my own personal labour, even for the minutest details. I have been urged to the work from many quarters. I thought seriously for some time whether I should or should not undertake a labour which will require for many years the whole of the time which is left to me from my other avocations. The diligent use which has been made by astronomers of the first part of my catalogue has induced me to take the matter in hand. In order that the work may come the sooner into the hands of astronomers, it will be divided into four parts, each of which will contain six hours of right ascension. Some days since I entered the last stars of the first six hours in the catalogue. The precessions, taken out of my own special tables, are still to be added for the fourth and fifth hours, and the first volume will then be finished. If my life should be spared, and especially sufficient rest of mind for so serious a work, I hope to be able to bring it to a termination. I may, in addition, remark, that this time the shape and printing will be altogether different from those of the first catalogue."

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*Brief Description of a small Equatoreal and Dome at Tarn Bank, near Cockermouth.* By Isaac Fletcher, F.R.A.S.

"Towards the close of the year 1847, I purchased from Thomas Cooke, of Coney Street, York, a 6-foot achromatic refractor, having a clear aperture of 4.14 inches, and mounted on a portable equatoreal stand constructed somewhat in the German style. A little experience in the use of this instrument convinced me of its excellent quality, and consequently I determined to erect an observatory to place it in, in order to give it full efficiency. The mounting being deemed not sufficiently stable and firm for a fixed instrument, an entirely new one with clock-work motion was ordered, and whilst these were in progress the observatory was erected.

"Owing to local obstruction, it was necessary that the floor of the observatory should be raised a considerable height above the surface of the ground. Accordingly, an octagonal stone tower, 18 feet in height and 14 feet diameter outside, was erected, on the walls of which a massive coping-stone was placed. On this coping-stone a circular building of brick is erected,  $6\frac{1}{2}$  feet in height, the walls of which are 9 inches thick. The internal diameter of this building (which constitutes the *observatory*) is 11 feet 3 inches, and the entrance into it is by means of a door in the floor, to which a staircase in the octagonal part of the building leads. The floor is 12 inches above the commencement of the circular brickwork, and is of wood. Across the centre of the floor, and in the direction of the astronomical meridian, are laid two massive beams of American pine timber, 12 inches square. These beams are placed close together *below* the boarding of the floor, of which they are entirely independent, not being in contact in any part whatever. On each end of the beams is raised a heavy piece of brickwork and Roman cement. The south pier is capped by a large block of sandstone, weighing about 5 cwt. This stone supports a small casting, in which is placed a small block of *lignum vitæ*, in which the lower pivot of the polar axis turns. On the north pier a stone column is placed, which bears on its summit a framing of cast-iron, to which the adjustments are attached for supporting the upper pivot of the polar axis. On the top of the circular wall a ring of wood is firmly fixed, to which is screwed the cast-iron channel in which the 3 four-inch balls rest, on which the dome revolves. Both the upper and lower rings are cast in one *entire* piece, and are beautiful specimens of loam casting.

"The dome is a perfect hemisphere, and is formed of a number of vertical ribs of the requisite curvature,  $4\frac{1}{2}$  inches broad and  $1\frac{1}{2}$  inch thick, which radiate from a large block of wood at the vertex of the dome. This framework is covered by  $1\frac{1}{2}$ -inch pine boarding, covered with canvass, and painted and sanded in the manner described by the Rev. W. R. Dawes, F.R.A.S., in his description of the Camden Lodge Observatory. (See *Mem. Roy. Astron. Soc.*, vol. xvi. p. 323.) The shutters of the roof-opening are of sheet-iron, bent to the curvature of the dome; they are two in number, and, when open, lay back against the dome.

"The telescope is mounted on a long polar axis, similar in principle to those adopted by Dollond in most of his equatorials. The tube is placed on *one side* of the polar axis, to the opposite side of which a leaden counterpoise is screwed. The polar axis is of mahogany, and is 9 feet long, 7 inches square at each end, and 9 inches square at the middle. The hour and declination circles are each 20 inches in diameter; they are divided on silver, and read by verniers, the former to  $2^s$  of time, and the latter to  $10''$  of space.

"The driving clock is a very elegant piece of workmanship, and performs its work with singular smoothness and regularity. The *regulation* is effected by means of a governor, precisely similar to

those used in steam-engines, the extra power being absorbed by a brass friction-wheel.

"There are seven negative eye-pieces attached to the telescope, the powers of which vary from 45 to 350, and two single lenses of 400 and 500 respectively.

"The positive eye-pieces of the micrometer are six in number, the powers of which vary from 50 to 420.

"The position-circle of the micrometer is divided on silver, and reads by two opposite verniers to single minutes of space. The heads of the screw are each divided into 100 parts, and by careful estimation each division may be subdivided into 5ths or 10ths.

"As evidence of the quality of the object-glass, it may be added that I can readily see the two companions of  $\tau$  Orionis, one of which is rated by Captain Smyth as of the 15th mag., Herschel's 'debilissima' couple between 1 and 5 Lyræ. I have also frequently seen, and under rare atmospheric circumstances, have caught up, the 5th star in the great nebula of Orion. The star 36 Andromedæ, the separation of which Sir J. Herschel adduces as a proof of the excellence of his celebrated 7-foot achromatic of 5 inches aperture, I have seen with power 400 completely severed.

"Both the building and the mounting of the instrument are remarkably firm and steady.

"The whole of the workmanship of this equatoreal, both optical and mechanical, is by Mr. Cooke, upon whom it reflects great credit.

"It is proposed to devote this instrument to an examination of a selected list of double stars, taken from Smyth's admirable 'Cycle.'"

*Note by Mr. Dawes, to his late Paper, "On the Phenomena attending the Disappearance of Saturn's Ring."*

"In my paper lately presented to the Society, 'On the Phenomena attending the Disappearance of Saturn's Ring,' I have stated that the brightest points visible on the obscure surface of the ring, namely, the eastern and western extremities, receive reflected light from *one-half only* of the illuminated surface of Saturn, which would be seen from them as a *half moon*.

"Soon after that paper was sent, it occurred to me that, as the plane of the ring coincides with the planet's equator, the parts of the ring in question would receive reflected light from *one quarter only* of Saturn's illuminated hemisphere, which would be seen from them as *the northern or the southern half of a half moon*. The *base* of this illuminated quadrant would appear *in the horizon*; and the angle subtended by it in *azimuth*, as seen from the exterior portion of the inner ring, would be about  $27\frac{1}{2}$  degrees; while, in consequence of the oblateness of Saturn's form, the *altitude* of the *quadrant* will be only about 25 degrees.

"This consideration greatly diminishes the probability of the reflected light received from *Saturn* by the extremities of the ring being sufficient to render its obscure surface so bright, that portions of it should rival the satellites themselves in brilliance, and proportionably increases the force of the argument in favour of a twilight produced by refraction of the solar rays.

"Respecting the invisibility of the *edge* of *Saturn's* ring, the testimony of Sir John Herschel is of great importance. In his *Outlines of Astronomy*, page 316, *note*, he says, 'Its disappearance was *complete* when observed with a reflector 18 inches in aperture, and 20 feet in focal length, on the 29th of April, 1833, by the author.'

"In my quotation on this subject from Sir W. Herschel, an *erratum* occurs in page 50, line 35, of the printed *Monthly Notices*, vol. x.; where, for 'any telescopes,' read 'my telescopes.'"

*Error in the Histoire C  leste.* By the President.

The star Lalande 11946, as named in Lalande's Catalogue published by the British Association, appears, on the authority of Mr. Maclear, to be 1<sup>m</sup> in error in right ascension.

Mr. Maclear has observed with the equatoreal all the stars in the immediate neighbourhood, and finds the following:—

R.A.			N.P.D.	Mag.
<sup>h</sup>	<sup>m</sup>	<sup>s</sup>	<sup>�</sup>	
6	7	35	64 27 50	9
6	9	25	64 25 8	7½
6	9	26	64 29 55	9½
6	9	26	64 36 10	8½

Now Lalande 11946, reduced with sufficient accuracy to the beginning of the present year, 1850, gives,

R.A.	N.P.D.
6 <sup>h</sup> 8 <sup>m</sup> 39 <sup>s</sup>	64 <sup>�</sup> 27' 44",

which agrees pretty well with the first of the above list, on the supposition that Lalande's R.A. is too great by 1<sup>m</sup>.

Again, the second of Maclear's list differs from the first by 1<sup>m</sup> 50<sup>s</sup>, and Lalande 11946 differs from 11977 (observed in sequence on the same evening) by 0<sup>m</sup> 50<sup>s</sup>; and, the second of Maclear being undoubtedly identical with No. 11977, it thus appears also that No. 11946 is in error 1<sup>m</sup> in excess.

Lastly, it would appear that Lalande 11975 is identical with 11977, and 11976 with 11978.

**Notes on the British Association Catalogue.** By Capt. W. S. Jacob,  
Director of the H. E. I. C.'s Observatory at Madras.

The undermentioned numbers have not been found in the  
places indicated :—

No.	90	R.A.	N.P.D.
434			
534	There is a star at	$1^{\text{h}} 37^{\text{m}} 30^{\text{s}}$	and $141^{\circ} 22'$
642	„	$1^{\text{h}} 57^{\text{m}} 33^{\text{s}}$	„ $143^{\circ} 45'$
969			
1088	is perhaps a duplicate of 1086, with error of $30'$		
3401	There is *	$9^{\text{h}} 49^{\text{m}} 45^{\text{s}}$	$134^{\circ} 14'$
3535	Perhaps a duplicate of 3541, $30^{\text{s}}$ out in R.A.		
4144	„	$4^{\text{h}} 14^{\text{m}} 10^{\text{s}}$	„
7264	„	$7^{\text{h}} 26^{\text{m}} 5^{\text{s}}$	$1^{\circ}$ out in N.P.D.

“The Nos. 719, 2511, 2766, marked as nebulae, appear in our transit  
(5 ft. focal length, and  $3\frac{1}{2}$  in. aperture) as loose clusters of small stars. Of course  
these may be nebulae not visible in our instrument.

“No. 2511 contains a small double star, which has been observed.

“Nos. 1728 and 1999 are double.”

---

Mr. Hind says, “I discovered on the 4th of January last a  
rather conspicuous nebula, the position of which for 1850 is—

R.A.  $12^{\text{h}} 0^{\text{m}} 33^{\text{s}}.16$ . N.P.D.  $23^{\circ} 59' 30''.1$ .

“It is elliptical, and has a decided nuclear condensation.

“In October, 1845, I found a highly-coloured crimson, or even  
scarlet, star in *Orion*, far the most deeply coloured object I have  
yet seen. Its mean place for 1850 is—

R.A.  $4^{\text{h}} 52^{\text{m}} 46^{\text{s}}.76$ . N.P.D.  $105^{\circ} 2' 9''.3$ .”

---

Mr. Fletcher sends the following remarks on the brightness of  
*Pollux* :—

“In the *Celestial Cycle* Captain Smyth remarks, ‘This star  
has been suspected of varying in lustre, since it is recorded as  
having at times been *brighter* than *Castor*, whence Bradley rated  
it of the first magnitude; others have classed it of the 3d rank;  
but Ptolemy, Tycho, Lacaille, Zach, and all the best authorities  
classify it as of the 2d.’

“At the moment I am writing *Pollux* is obviously and unmis-  
takably brighter than *Castor*, and I think it brighter, at any rate  
*fully* as bright, as *Ursæ Majoris*. How long it may have been  
so I am unable to say, and can only speak of the present appear-  
ance.”

*Extract of a note from Mr. G. S. Spreeckley, of Shang Hai, to the Secretary, respecting  $\eta$  Argûs.*

"On my voyage from Suez to Penang, my attention was excited by the unexpected splendour of  $\eta$  Argûs, which is now a large first magnitude, surpassing every other star in the constellation except *Canopus*. . . . Seen with the naked eye, or with a glass, there was a manifest difference in colour between the rays of light from its SW. and from its NE. position, the former being brilliant red, and the latter a bluish green. Is it a double star?"

Dr. Forster calls attention to the simultaneous phenomena of numerous solar spots and unusual cold, which have occurred since March 18th. It is remarkable, that during the nights of severest cold the wind has blown from the south and south-east, which is to be viewed in connexion with the extraordinary cold felt in the Levant, and particularly at Constantinople, during the present spring.

#### Discovery of a Comet at Altona.

Professor Schumacher has sent the following particulars of a faint telescopic comet discovered at the Observatory of Altona by Dr. Petersen:—

	Altona M.T.	R.A. h m s	Decl. ° ' "	
May 1	10 0 0	19 25 0	+ 71 10 0	approximate.
2	11 0 0	19 24 7.9	+ 17 19 34	

Hourly Change in R.A. =  $-2''$ ; in Declin. =  $+20''$ .

#### Errors in Captain Shortrede's Table of Logarithms to Numbers. By Mr. Galbraith.

Page 31 log. to 24451 for 3882996 read 3882966

43	38962	5906413	5906412
----	-------	---------	---------

50 parts		729	728
----------	--	-----	-----

56	54033	7326541	7326591
----	-------	---------	---------

59	57628	7606336	7606335
----	-------	---------	---------

59	57629	7606410	7606411
----	-------	---------	---------

64	63747	8044597	8044598
----	-------	---------	---------

81	85071	9296815	9297815
----	-------	---------	---------

93	99286	9968800	9968880
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## ROYAL ASTRONOMICAL SOCIETY.

VOL. X.

May 10, 1850.

No. 7

G. B. AIRY, Esq., President, in the Chair.

Sir R. I. Murchison, Belgrave Square, was balloted for and duly elected a Fellow of the Society.

The President read the following letter from Sir John Ross:—

*“London, 6th May, 1850.”*

“Sir,—I am to request that you will be pleased to inform the President and Council of the Royal Astronomical Society that an expedition of discovery and research, under my direction, will sail from Loch Ryan on the 23d inst., to Baffin's Bay, and that I shall be happy to give every attention in my power to any wishes or instructions I may be honoured with from the Royal Astronomical Society.—I am, with truth and regard, Sir, your most obedient servant,  
JOHN ROSS.

“N.B.—Letters posted in London on the 21st inst., will reach me in time if addressed to me at ‘Northwest Castle, Stranraer.’

*“To the Secretary of the Royal Astronomical Society.”*

The thanks of the meeting were returned to Sir John Ross for his obliging offer.

The President then made a statement to the following effect:—  
After completing the lunar reductions, and before engaging in any theoretical investigation, Mr. Airy made inquiry whether any mathematician was pursuing the same subject, when it appeared that Professor Hansen had undertaken this most difficult and important problem under the patronage, and with the pecuniary assistance, of the late King of Denmark. The matter was considered to be in the most satisfactory hands, as respected the power of the analyst and the singular intelligence of the patron. Some communications from Professor Hansen to the Royal Astronomical Society have shown the zeal and success with which he has prosecuted his researches,\* but the death of the King of Denmark, and the unfortunate political differences which have lately disturbed that kingdom, threatened

\* See *Memoirs*, vol. xvi. p. 465, and *Monthly Notices*, vol. vii. p. 275.

an interruption of the means necessary to carry on the computations and make the results public. Under these circumstances, and feeling that a correct theory of the moon, which should represent the immense series of Greenwich lunar observations, was not only most desirable in itself, but intimately connected with the Royal Observatory\* and our national interests, Mr. Airy applied to the Lords Commissioners of the Admiralty for the small sum required to enable Professor Hansen to complete his work: it is almost needless to add that this was immediately granted in the handsomest manner.

The President stated that he had received from Dr. Henderson (now of Greenbank, St. Helen's, Lancashire) a new set of numbers for the teeth of wheels in a train to convert revolutions in solar time into revolutions in sidereal time, to which probably nothing comparable in accuracy had ever been produced. Dr. Henderson's numbers given in a former communication were founded upon a value of the sidereal day, differing from that in the *Nautical Almanac* by a perfectly insignificant quantity. This apparent difference, however, had stimulated Dr. Henderson to attempt a new combination of wheels, and he had discovered the following:—

If a spindle revolving in 24 solar hours carry a wheel of 50 teeth, which works in a wheel of 30 teeth on the second spindle; and if the second spindle carry a wheel of 182 teeth, which works in a wheel of 211 teeth on the third spindle; and if the third spindle carry a wheel of 196 teeth, which works in a wheel of 281 teeth on the fourth spindle,—then the time of revolution of that fourth spindle, in mean solar seconds, will be

$$86164^{\text{s}}.090603274$$

The length of the sidereal day adopted in the *Nautical Almanac* is

$$86164^{\text{s}}.0906.$$

It is evident that these numbers are practically identical, inasmuch as the figures are the same as far as it has been thought necessary to retain decimals in the *Nautical Almanac*. Dr. Henderson estimates the difference at 1 second in 855 years, but even this estimation is too great.

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### THE NEW PLANET PARTHENOPE.

Dr. Annibale de Gasparis, assistant at the Royal Observatory, Naples, in a letter to Sir John Herschel, announces his discovery

\* The Royal Observatory of Greenwich was established for the express purpose of observing the moon, and rendering her motions useful to navigation; this object has been kept steadily in view for more than 150 years, and with complete ultimate success.

of a new planet on the 11th of May. He states that he had used his utmost endeavours to realise a "Parthenope" in the heavens, such being the name which had been suggested by Sir John Herschel on the occasion of the discovery of *Hygeia* in 1849. The planet shone as a star of the ninth magnitude.

Observations.

NAPLES.

(Dr. A. de Gasparis.)

	Naples M.T.	R.A.	N.P.D.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>o</sup> <sup>'</sup> <sup>"</sup>	<sup>o</sup> <sup>'</sup> <sup>"</sup>
May 11	12 51 53.1	230 21 53.2	100 35 12.9
12	11 42 2.8	230 8 28.6	31 58.9
13	12 6 35.6	229 53 41.2	28 35.5
14	10 28 16.8	40 36.0	25 31.1
15	9 52 50.5	229 26 25.0	22 39.1
17	10 59 36.0	228 57 7	16 42
18	11 14 36.2	42 41.8	13 52.5
19	10 18 43.3	29 20.2	11 13.8
20	10 0 37.3	228 15 30.5	100 8 33.1

CAMBRIDGE. Northumberland Equatoreal. (Prof. Challis.)

	Greenwich M.T.	R.A.	N.P.D.	No. of Comps.		Star.
1850.	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>o</sup> <sup>'</sup> <sup>"</sup>	R.A.	N.P.D.	
May 30	9 55 48.3	15 4 17.81	99 49 11.0	1	1	a
	11 20 54.7	14.53	7.5	2	1	b
June 1	11 14 58.1	15 2 41.69	99 46 46.2	10	10	b

On the Meridian.

June 1	10 22 10.7	15 2 43.50	99 46 50.3
2	17 30.5	1 59.10	45 53.8
3	12 50.9	1 15.26	45 9.4
4	10 8 12.5	15 0 32.64	44 30.8
7	9 54 27.7	14 58 35.24	43 28.7
8	9 49 55.5	14 57 58.89	99 43 22.0

Assumed Mean Places of the Stars, 1850.0.

	R.A.	N.P.D.	
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>o</sup> <sup>'</sup> <sup>"</sup>	
a	15 9 24.98	99 56 42.2	Beasel xv. 160
b	15 7 58.09	100 2 17.6	— 132

The place of *b* was determined by two transit and two circle observations: that of *a* is taken from Weiss's catalogue.

LIVERPOOL.			Equatoreal.		(Mr. Hartnup.)		
	Greenwich M.T.			R.A.	Log $\frac{p}{P}$	N.P.D.	Log $\frac{q}{P}$ Star of Comp.
1850.	h	m	s	h	m	s	
June 2	10	23	49.9	15	1 58.76	-7.0243	99 45 59.26 -9.9488 $\beta$ Librae
	11	3	42.9		57.44	+7.7761	53.51 9.9483 —
3	11	44	56.6	15	1 12.66	8.1405	99 45 7.77 9.9458 —
	12	4	53.4		12.06	8.2324	5.53 9.9441 —
	12	24	50.4		11.56	+8.3054	5.14 -9.9421 —

The observations are corrected for refraction. The corrections to be applied for parallax in time and arc are represented by  $p$  and  $q$ .  $P$  is the equatoreal horizontal parallax.

The following is the assumed place of  $\beta$  Librae derived from the Greenwich Twelve-year Catalogue:—

For January 1, 1850.0.

Mean R.A.			Mean N.P.D.		
h	m	s	°	'	"
15	8	56.50	98	49	33.08

#### LIVERPOOL. 20-foot Equatoreal. (Mr. Lassell.)

	Greenwich M.T.			R.A.	N.P.D.
				* — Planet.	Planet — *
1850.	h	m	s		
May 31	12	46	57.58	22.73	....
	12	59	57.03	....	56.35

The star and planet of equal brightness, a good tenth magnitude.

The star may be thus identified:—

It precedes  $a$  by 1 22.0 and is South of  $a$  1 14.1

It follows  $b$  in 0 11.2 North  $b$  9 19.5

Approximate places of  $a$  and  $b$ , from Harding's Catalogue for 1800, accompanying the xv. hour of the Berlin Maps:—

	Mag.	R.A.	N.P.D.
1800		h m s	° ' "
$a$	9	15 2 26	99 33.9
$b$	9	15 0 53	99 45.5

#### DURHAM. Equatoreal. (Prof. Chevallier and Mr. R. C. Carrington.)

	Greenwich M.T.			R.A.	N.P.D.
1850.	h	m	s	h m s	° ' "
June 1	12	50	39.2	15 2 38.44 +0.023 $p$	99 46 48.4 -0.882 $p$

Compared with Weisse xv. 45, eleven times in R.A. and four times in N.P.D.

#### REGENT'S PARK. (MM. Bishop and Hind.)

	Greenwich M.T.			R.A.	N.P.D.
1850.	h	m	s	h m s	° ' "
May 30	11	31	41	15 4 14.31	99 49 5.8
31	10	36	23	15 3 29.16	99 47 55.4

The planet appeared as bright as stars of the 9.10th magnitude. The above places depend on the position of No. 45, Hour xv. of Weisse's catalogue.

HAMBURG.

(M. C. Rümker.)

	Hamburg M.T. h m s	R.A. ° ' "	N.P.D. ° ' "	
May 27	11 40 8.7	226 40 37.5	99 53 35.2	Equatoreal.
28	10 41 34.4	28 30.1	52 4.2	Mer. Circle.
29	36 49.6	16 15.0	50 30.6	—
30	32 6.1	226 4 18.4	49 15.0	—
31	27 23.1	225 52 32.5	47 59.0	—
June 1	22 41.6	41 6.5	46 52.8	—
2	18 0.1	29 55.8	45 58.2	—
3	10 13 22.2	225 19 7.9	99 45 12.0	—

ALTONA.

(Prof. Schumacher.)

	M.T. h m s	R.A. ° ' "	N.P.D. ° ' "	
May 28	11 25 8	226 28 17.4	99 52 1.9	Equatoreal.
June 1	10 22 41	225 41 6.1	46 55.0	Mer. Circle.
2	18 1	29 58.6	.....	—
3	10 13 22	225 19 6.0	99 45 8.7	—

BERLIN.

(Prof. Encke.)

	Berlin M.T. h m s	R.A. ° ' "	N.P.D. ° ' "	
May 25	11 12 8.0	227 6 42.2	99 57 16.5	Equatoreal.
27	10 20 26.2	226 41 28.0	99 53 40.4	—

Elements.

From the observations of May 12 and 28 Mr. Weyer has calculated the following *circular* elements, which are stated by Prof. Schumacher to represent the observations during May with great accuracy:—

Longitude, May 12.4773, Mean Berlin Time = 231° 1' 31".8, M. Eq. 1850

Ascending Node ..... 128° 57' 42".7

Inclination ..... 4 29 52".1

Log. radius of Orbit ..... 0.376901

Log. diurnal Motion in seconds... 2.984655

Sidereal Period 1343 days.

*Elliptic.* By M. George Rümker.

Perihelion Passage, 1851, Feb. 15.663509 Mean Greenwich Time.

Longitude Perihelion ..... 315 33 25.2 } Mean Equinox,  
— Ascending Node ..... 125 39 4.2 } 1850, Jan. 1.

Inclination ..... 4 33 8.2

$\phi$  ..... 5 54 41

$e$  ..... 0.1030387

Log. semi-axis Major ..... 0.38472636

Sidereal Revolution ..... 1379.39 days.

## IRIS.

LIVERPOOL.			Equatoreal.			(Mr. Hartnup.)		
Greenwich M.T.			R.A.			Comp <sup>d</sup> —Obs <sup>d</sup> .		Star of
1850.	h	m	s	h	m	s	R.A. N.P.D.	Comparison.
May 9	12	24	0'0	15	39	52'53	113 9 31'1	+0'12 +0'5 42 Libræ.
12	12	32	41'9	15	36	52'72	112 56 10'0	+0'22 +0'7 —
14	12	20	20'2	15	34	52'36	112 46 59'2	+0'23 -1'7 —
June 2	10	38	24'5	15	16	35'66	111 11 8'2	+0'09 -0'1 —

The observations are corrected for refraction and parallax.

The computed places were deduced from the Supplement to the *Nautical Almanac* for 1853.

The following assumed place of the star of comparison is derived from the Greenwich Twelve-year Catalogue:—

For Jan. 1, 1850.		
Mean R.A.	Mean N.P.D.	
42 Libræ	15 <sup>h</sup> 31 <sup>m</sup> 25 <sup>s</sup> ·37	113° 19' 33"·29

## HYGEIA.

CAMBRIDGE.			Northumberland Equatoreal.			(Prof. Challis.)		
Greenwich M.T.			R.A.			No. of Comps.		Star.
1850.	h	m	s	h	m	s	R.A. N.P.D.	
May 15	13	58	2'6	19	44	35'33	112 12 54'6	1 1 a
	14	10	56'9			35'04	54'0	1 1 b
28	14	38	4'6	43	58	69	112 3 36'7	10 10 c
June 7	12	33	37'0	19	40	44'36	112 1 57'1	3 3 a
	12	50	56'6			44'24	55'9	6 3 c

Not corrected for parallax.

Assumed Mean Places of the Stars, 1850'0.

	R.A.		N.P.D.	Authority.
	h	m	s	
a	19	30	59'71	112 23 52'1 H.C. 37221
b	19	38	48'41	112 41 3'6 Not in catalogues.
c	19	41	27'85	112 0 42'6 —

The places of the stars *b* and *c* were determined by three equatoreal comparisons with H.C. 37221, and are somewhat uncertain.

## JUNO.

LIVERPOOL.			Equatoreal.			(Mr. Hartnup.)		
Greenwich M.T.			R.A.			Comp <sup>d</sup> —Obs <sup>d</sup> .		Stars of
1850.	h	m	s	h	m	s	R.A. N.P.D.	Comparison.
April 30	12	29	9'2	13	4	29'11	86 30 8'4	+2'64 +13'5 3 Virginis.
May 1	9	23	50'5	3	56	77	26 0'6	+2'77 +13'5 —
5	11	8	43'4	13	0	35'46	86 8 25'1	+2'63 +12'4 —

The observations are corrected for refraction and parallax.

The following assumed place of the star of comparison has been obtained from the Greenwich Twelve-year Catalogue:—

For Jan. 1, 1850.

	Mean R.A.	Mean N.P.D.
♌ Virginis	12 <sup>h</sup> 48 <sup>m</sup> 21 <sup>s</sup> ·90	85° 47' 11"·67

# PETERSEN'S THIRD COMET.

## Observations.

	CAMBRIDGE.	Northumberland	Equatoreal.	(Prof. Challis.)	
	Greenwich M.T.	R.A.	N.P.D.	No. of Comp.	Star.
1850.	h m s	h m s	° ' "		
May 9	12 10 49·6	19 13 30·09	17 30 43·0	4	a
	13 8 2·7	26·08	17 30 20·5	4	a
11	11 16 3·3	19 9 3·16	17 12 22·6	6	b
15	12 54 38·2	18 57 21·36	16 37 21·4	4	b
20	10 54 16·4	38 15·71	16 3 3·8	6	c
22	11 54 58·4	18 28 24·59	15 52 31·5	7	d
29	11 24 35·1	17 47 39·36	15 46 44·9	1	e
June 3	11 41 54·8	17 11 45·38	16 22 3·0	2	f

## On the Meridian.

June 3	12 22 46·2	17 11 31·85	16 22 30·9
7	11 36 58·4	16 41 22·85	17 24 49·4
8	11 25 29·4	16 33 48·46	17 46 5·0

The observations are not corrected for parallax. The first set of comparisons on May 9 was taken by oblique transits at bars inclined alternately +45° and -45° to the parallel of declination; the differences of north polar distance in the other set are micrometer measures.

## Assumed Mean Places of the Stars 1850.

	R.A.	N.P.D.	Authority.
	h m s	° ' "	
a	19 20 32·55	17 32 50·7	Argelander Z. 31 No. 51
b	19 6 28·62	16 51 20·7	— 31 No. 38
c	18 31 43·97	16 20 22·3	— 31 No. 1
d	18 27 20·60	15 55 12·0	— 124 No. 162
e	17 42 14·10	15 33 23·3	— 122 No. 120
f	17 16 23·62	17 2 19·7	— 124 No. 69

## DURHAM.

	Greenwich M.T.	R.A.	N.P.D.	Set.
	h m s	h m s	° ' "	
May 9	12 54 35·4	19 13 25·1	-0·096 p	17 29 51 +0·119 p (1)
12	10 52 40·0	19 6 36·56	0·127 p	17 3 17·3 -0·093 p (2)
	11 31 15·5	19 6 33·75	0·119 p	17 3 7·6 -0·006 p (3)
14	13 26 24·1	19 0 33·56	0·072 p	..... (4)
	13 26 10·4	19 0 34·72	0·072 p	16 45 1·9 +0·231 p (5)
15	11 53 12·5	18 57 35·16	0·109 p	16 37 30·7 +0·091 p (6)
29	12 46 26·4	17 47 17·00	-0·026 p	15 46 35·1 +0·328 p (7)

Star of Comparison.	Assumed Apparent Places.		No. of Diff. taken.	
	R.A.	N.P.D.	In R.A.	In N.P.D.
Argelander, Zone 31, No. 51	19 20 35 <sup>h</sup> 22 <sup>m</sup>	17 33 1 <sup>o</sup> 3	1	(1)
— No. 38	19 6 31 <sup>h</sup> 91 <sup>m</sup>	16 51 29 <sup>o</sup> 1	8	5 (2)
τ Draconis	19 18 27 <sup>h</sup> 86 <sup>m</sup>	16 55 40 <sup>o</sup> 5	7	2 (3)
Argelander, Zone 31, No. 38	19 6 32 <sup>h</sup> 01 <sup>m</sup>	.....	6	0 (4)
τ Draconis	19 18 27 <sup>h</sup> 98 <sup>m</sup>	16 55 40 <sup>o</sup> 1	7	2 (5)
Argelander, Zone 31, No. 38	19 6 32 <sup>h</sup> 09 <sup>m</sup>	16 51 28 <sup>o</sup> 4	10	3 (6)
— 126, No. 97	17 40 11 <sup>h</sup> 31 <sup>m</sup>	15 54 35 <sup>o</sup> 3	11	4 (7)

LIVERPOOL. Equatoreal. (Mr. Hartnup.)

	Greenwich M.T.	R.A.	Log $\frac{p}{P}$	N.P.D.	Log $\frac{q}{P}$	Star of Comp.
May 8	12 34 20 <sup>h</sup> 4	19 15 29 <sup>h</sup> 17 <sup>m</sup>	-9 <sup>o</sup> 04 04	17 39 58 <sup>o</sup> 4	+8 <sup>o</sup> 84 21	τ Draconis
9	10 55 45 <sup>h</sup> 0	13 36 91 <sup>m</sup>	-9 <sup>o</sup> 11 50	31 10 1	-9 <sup>o</sup> 15 10	—
12	10 59 53 <sup>h</sup> 5	6 32 10	-9 <sup>o</sup> 11 53	17 3 16 <sup>o</sup> 2	-8 <sup>o</sup> 89 96	τ Draconis
14	13 3 26 <sup>h</sup> 6	19 0 24 49	-8 <sup>o</sup> 76 23	16 44 51 <sup>o</sup> 5	+9 <sup>o</sup> 46 11	—
21	11 20 23 <sup>h</sup> 7	18 33 33 44	-9 <sup>o</sup> 12 66	15 57 40 <sup>o</sup> 8	+9 <sup>o</sup> 05 72	B.A.C. 6469-6514
28	12 15 5 <sup>h</sup> 3	17 53 58 22	-8 <sup>o</sup> 73 05	44 21 <sup>o</sup> 0	+9 <sup>o</sup> 50 24	B.A.C. 6001
29	11 20 55 <sup>h</sup> 8	47 38 03	-8 <sup>o</sup> 88 97	15 46 43 <sup>o</sup> 9	+9 <sup>o</sup> 41 94	—
June 2	12 45 41 <sup>h</sup> 8	18 57 07	+6 <sup>o</sup> 75 85	16 12 0 <sup>o</sup> 0	+9 <sup>o</sup> 54 02	—
3	13 32 43 <sup>h</sup> 0	17 11 15 25	+8 <sup>o</sup> 52 00	16 23 12 <sup>o</sup> 9	+9 <sup>o</sup> 51 44	—
17	12 31 42 <sup>h</sup> 5	15 29 15 07	+8 <sup>o</sup> 79 95	23 9 7 <sup>o</sup> 5	+9 <sup>o</sup> 06 14	B.A.C. 5406
—	13 31 19 <sup>h</sup> 7	0 31	+8 <sup>o</sup> 90 99	11 16 <sup>o</sup> 5	+8 <sup>o</sup> 06 84	—

The mean places for 1850 of the comparison stars are assumed as follows:—

	R.A.	N.P.D.	
τ Draconis	19 32 38 <sup>h</sup> 52 <sup>m</sup>	20 35 37 <sup>o</sup> 8	Greenwich Twelve-Year Catalogue
τ Draconis	19 18 24 <sup>h</sup> 38 <sup>m</sup>	16 55 27 <sup>o</sup> 7	Oxford Observations.
B.A.C. 6469	18 49 29 <sup>h</sup> 46 <sup>m</sup>	16 5 23 <sup>o</sup> 6	—
— 6514	18 56 43 <sup>h</sup> 02 <sup>m</sup>	16 6 46 <sup>o</sup> 6	—
— 6001	17 36 50 <sup>h</sup> 67 <sup>m</sup>	15 40 57 <sup>o</sup> 9	—
— 5406	16 5 55 <sup>h</sup> 92 <sup>m</sup>	21 47 39 <sup>o</sup> 6	Greenwich Twelve-Year Catalogue

STONE. On the Meridian. (Rev. J. B. Reade, and Mons. V. Fasel.)

	Approx. N.P.D.	R.A.		Approx. N.P.D.	R.A.
1850.			1850.		
June 2	16 12	17 18 56 <sup>h</sup> 76 <sup>m</sup>	June 12	19 27	16 4 2 <sup>h</sup> 77 <sup>m</sup>
3	16 20	17 11 38 <sup>h</sup> 47 <sup>m</sup>	13	20 7	15 56 52 <sup>h</sup> 93 <sup>m</sup>
4	16 29	17 4 10 <sup>h</sup> 46 <sup>m</sup>	15	21 30	15 43 4 <sup>h</sup> 34 <sup>m</sup>
7	17 3	16 41 22 <sup>h</sup> 35 <sup>m</sup>	16	22 18	15 36 22 <sup>h</sup> 55 <sup>m</sup>
8	17 18	16 33 44 <sup>h</sup> 38 <sup>m</sup>	17	23 6	15 29 58 <sup>h</sup> 50 <sup>m</sup>
9	17 51	16 26 21 <sup>h</sup> 90 <sup>m</sup>			

\* Latitude 51° 47' 57" North.  
Longitude 3° 29' 09" West.

These observations are corrected for instrumental errors. The system of wires in the Stone transit consists of the usual fine webs, and an intermediate set of wires of about  $\frac{1}{100}$ th of an inch in diameter. The latter are visible on a darkened field when the former cannot be seen. The comet being a very faint object, could only be observed on the thicker wires with the field darkened. The N.P.D. is the reading of the small circle attached to the transit.

HAVERHILL.

(Mr. W. W. Boreham.)

Greenwich M.T.				R.A.	N.P.D.	Stars of Comparison.
Year.	h	m	s	h	m	s
May 11	10	8	42	19 9 3'29	-p 0'139	17 12 53'3 -p 0'17 Arg. Z. 31, No. 38.
18	11	14	20	18 46 32'72	0'122	16 13 49'4 +p 0'107 Groomb. 2710, Radcliffe Obs.
20	10	28	28	18 38 12'92	0'133	16 3 24'5 0'048 Arg. Z. 122, No. 198.
26	10	50	30	18 6 44'65	0'029	15 43 11'9 0'208 Arg. Z. 122, No. 155.
28	10	34	27	17 54 20'13	0'107	15 44 7'8 0'215 H. Cél. 33239, and 33244, mean taken.
30	10	20	44	17 41 4'94	0'099	15 50 19'2 0'226 Arg. Z. 126, No. 97.
June 1	10 47	36		17 26 53'02	0'074	16 3 21'1 0'292 $\alpha$ and $\beta$ .*
2	10	46	23	17 19 32'62	0'099	16 11 52'2 0'217 Arg. Z. 126, No. 72.
3	10	48	47	17 12 3'62	0'059	16 21 47'7 0'317 Groomb. 2420, Radcliffe Obs.
4	10	49	0	17 4 38'88	-p 0'051	16 34 10'3 0'325 —
8	12	1	19'6	16 33 34'77	+p 0'02	17 46 43'4 0'338 Arg. Z. 126, No. 15.
11	11	40	46'6	16 11 2'70	0'026	19 9 27'15 0'306 — 115, No. 154.
13	11	22	0'6	15 56 39'63	0'026	20 13 27'49 0'283 — 116, No. 132.
15	11	40	19'5	15 42 38'74	0'044	21 33 42'4 0'232 Groomb. 2263, Radcliffe Obs.
16	11	4	2'6	15 36 10'33	+p 0'028	22 16 57'39 +p 0'149 Arg. Z. 116, No. 114.

\*  $\beta$  = Arg. Z. 126, No. 72 Comet follows  $\alpha$  2 54'0 Comet south of  $\alpha$  7 43'2  
 $\alpha$  follows  $\beta$  2 56'4  $\alpha$  south of  $\beta$  12 57'4

p = Hor. Eq. Parallax of Comet in seconds, time and arc, respectively.

ALTONA.

(Dr. Petersen and M. R. Schumacher.)

	Altona M.T.			R.A.	Decl.	
	h	m	s	h	m	s
May 2	9	48	22.4	291 2	38.4	+ 71 19 4.8
	12	12	8.3	0	19.8	55.8
	13	37	7.8		34.8	.....
3	9	52	25.3	.....		71 28 50.7
	10	15	47.3	290 46	41.7	.....
	11	48	37		46 45.3	29 42.7
4	12	54	43	290 26	18.5	71 40 4.0
7	10	46	55.9	289 21	3.2	72 9 14.8
8	10	26	43.0	288 54	54.6	18 42.2
12	10	27	47.2	.....		72 56 11.8
	10	32	58.7	286 39	3.9	.....
13	11	13	50.4	285 56	32.0	73 5 13.3
25	13	59	11.6	273 1	28.4	74 16 2.1
26	13	49	17	271 34	0.3	+ 74 16 54.8

## BERLIN.

	Berlin M.T.	R.A.	(Prof. Encke.)
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
May 5	10 42 56.4	290 9 44.4	+71 49 12.2

## KÖNIGSBERG.

	Königsberg M.T.	R.A.	(Dr. Wichmann.)
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
May 13	10 53 36	285 58 36.2	+73 5 5.2

## PARIS.

	Paris M.T.	R.A.	Decl.
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
May 10	11 7 18	287 50 30	+72 38 19.1
12	12 33 56	286 33 24.0	+72 57 26.6

## HAMBURG.

	Hamburg M.T.	R.A.	(M. C. Rümker.)
	<sup>h</sup> <sup>m</sup> <sup>s</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>	<sup>°</sup> <sup>'</sup> <sup>"</sup>
May 2	10 20 36.0	291 2 15.0	+71 18 55.8
3	10 37 3.7	290 47 30.5	29 13.9
4	12 15 48.9	290 28 25.2	71 40 13.6
7	10 56 17.4	289 20 28.2	72 9 12.0
8	10 13 50.8	288 55 29.8	18 43.6
10	11 35 16.3	287 53 8.3	38 46.8
12	11 36 48.1	286 38 13.0	72 56 38.3
13	11 47 25.1	285 56 13.2	73 5 14.0
14	13 27 48.9	285 8 36.2	14 27.3
15	10 54 0.9	284 26 20.3	21 45.3
18	11 36 0.4	281 40 49.2	44 30.3
19	12 23 13.0	280 36 54.0	51 3.2
20	13 7 23.0	279 29 49.1	73 57 15.5
23	12 19 21.6	275 52 39.3	74 10 37.0
25	11 14 0.7	273 11 14.3	+74 15 35.4

## Elements.

I. By Mr. Richard Schumacher, from the *Altona Observations* of May 3d, 8th, and 13th.

Perihelion passage 1850, July 23, 10759 Berlin M.T.

$\pi$ .....	273 16 19.9	} App <sup>t</sup> . Eq. May 1.
$\Omega$ .....	92 47 11.8	
$i$ .....	68 6 38.6	
Log $q$ ...	0.0334850	
Motion direct.		

From these elements the following ephemeris has been computed:—

Ephemeris for 12<sup>h</sup> M.T. at Berlin, by Mr. R. Schumacher.

	App <sup>d</sup> . R.A.	Hourly Var. in R.A.	App <sup>d</sup> . Decl.	Hourly Var. in Decl.	Log. Δ
1860. May 2 <sup>5</sup>	291 1 7 <sup>3</sup>	—0 36 <sup>9</sup>	+71 19 40 <sup>8</sup>	+25 <sup>2</sup>	0 <sup>1</sup> 17882
3 <sup>5</sup>	290 45 19 <sup>9</sup>	42 <sup>1</sup>	29 45 <sup>4</sup>	25 <sup>2</sup>	0 <sup>1</sup> 17468
4 <sup>5</sup>	290 27 25 <sup>9</sup>	47 <sup>5</sup>	39 48 <sup>0</sup>	25 <sup>1</sup>	0 <sup>1</sup> 17048
5 <sup>5</sup>	290 7 19 <sup>3</sup>	53 <sup>1</sup>	49 47 <sup>6</sup>	24 <sup>9</sup>	0 <sup>1</sup> 16619
6 <sup>5</sup>	289 44 54 <sup>7</sup>	—0 59 <sup>0</sup>	+71 59 43 <sup>2</sup>	24 <sup>7</sup>	0 <sup>1</sup> 16183
7 <sup>5</sup>	289 20 7 <sup>2</sup>	—1 5 <sup>1</sup>	+72 9 33 <sup>5</sup>	24 <sup>5</sup>	0 <sup>1</sup> 15739
8 <sup>5</sup>	288 52 49 <sup>1</sup>	11 <sup>5</sup>	19 17 <sup>3</sup>	24 <sup>2</sup>	0 <sup>1</sup> 15287
9 <sup>5</sup>	288 22 54 <sup>8</sup>	18 <sup>1</sup>	28 53 <sup>4</sup>	23 <sup>8</sup>	0 <sup>1</sup> 14827
10 <sup>5</sup>	287 50 17 <sup>3</sup>	25 <sup>0</sup>	38 20 <sup>5</sup>	23 <sup>4</sup>	0 <sup>1</sup> 14357
11 <sup>5</sup>	287 14 50 <sup>9</sup>	32 <sup>2</sup>	47 36 <sup>6</sup>	+22 <sup>9</sup>	0 <sup>1</sup> 13880
12 <sup>5</sup>	286 36 28 <sup>0</sup>	39 <sup>7</sup>	+72 56 39 <sup>8</sup>	22 <sup>3</sup>	0 <sup>1</sup> 13394
13 <sup>5</sup>	285 55 2 <sup>3</sup>	47 <sup>5</sup>	+73 5 28 <sup>7</sup>	21 <sup>7</sup>	0 <sup>1</sup> 12898
14 <sup>5</sup>	285 10 27 <sup>6</sup>	—1 55 <sup>5</sup>	14 0 <sup>6</sup>	21 <sup>0</sup>	0 <sup>1</sup> 12395
15 <sup>5</sup>	284 22 36 <sup>9</sup>	—2 3 <sup>8</sup>	22 13 <sup>7</sup>	20 <sup>1</sup>	0 <sup>1</sup> 11881
16 <sup>5</sup>	283 31 24 <sup>6</sup>	12 <sup>3</sup>	30 5 <sup>0</sup>	19 <sup>1</sup>	0 <sup>1</sup> 11357
17 <sup>5</sup>	282 36 43 <sup>7</sup>	21 <sup>1</sup>	37 32 <sup>0</sup>	18 <sup>1</sup>	0 <sup>1</sup> 10823
18 <sup>5</sup>	281 38 29 <sup>8</sup>	30 <sup>1</sup>	44 31 <sup>8</sup>	16 <sup>9</sup>	0 <sup>1</sup> 10279
19 <sup>5</sup>	280 36 36 <sup>6</sup>	39 <sup>3</sup>	51 1 <sup>2</sup>	15 <sup>5</sup>	0 <sup>1</sup> 09724
20 <sup>5</sup>	279 31 0 <sup>8</sup>	48 <sup>7</sup>	+73 56 56 <sup>7</sup>	14 <sup>0</sup>	0 <sup>1</sup> 09159
21 <sup>5</sup>	278 21 38 <sup>2</sup>	—2 58 <sup>2</sup>	+74 2 14 <sup>9</sup>	+12 <sup>4</sup>	0 <sup>1</sup> 08582
22 <sup>5</sup>	277 8 26 <sup>3</sup>	—3 7 <sup>8</sup>	6 51 <sup>6</sup>	10 <sup>6</sup>	0 <sup>1</sup> 07995
23 <sup>5</sup>	275 51 24 <sup>0</sup>	17 <sup>4</sup>	10 42 <sup>8</sup>	8 <sup>6</sup>	0 <sup>1</sup> 07396
24 <sup>5</sup>	274 30 30 <sup>5</sup>	27 <sup>0</sup>	13 43 <sup>5</sup>	6 <sup>4</sup>	0 <sup>1</sup> 06785
25 <sup>5</sup>	273 5 47 <sup>8</sup>	36 <sup>5</sup>	15 49 <sup>3</sup>	4 <sup>0</sup>	0 <sup>1</sup> 06162
26 <sup>5</sup>	271 37 19 <sup>2</sup>	45 <sup>8</sup>	16 54 <sup>8</sup>	+ 1 <sup>4</sup>	0 <sup>1</sup> 05528
27 <sup>5</sup>	270 5 10 <sup>7</sup>	54 <sup>9</sup>	16 54 <sup>9</sup>	— 1 <sup>4</sup>	0 <sup>1</sup> 04880
28 <sup>5</sup>	268 29 29 <sup>0</sup>	—4 3 <sup>5</sup>	15 43 <sup>7</sup>	4 <sup>5</sup>	0 <sup>1</sup> 04219
29 <sup>5</sup>	266 50 24 <sup>4</sup>	—4 11 <sup>7</sup>	+74 13 15 <sup>1</sup>	— 7 <sup>9</sup>	0 <sup>1</sup> 03546

The hourly movement is for Berlin Midnight.

Comparison of the Observations with Mr. R. Schumacher's Ephemeris.

so. ay	M.T. at place.	R.A.	Parall.	North Decl.	Parall.	Errors of Ephem. Δ α cos δ Δ δ	
2	Altona 9 48 22 <sup>4</sup>	291 2 38 <sup>4</sup>	—10 <sup>3</sup>	71 19 4 <sup>8</sup>	+2 <sup>2</sup>	+ 0 <sup>4</sup>	+20 <sup>9</sup>
	Hamburg 10 20 36	2 15	10 <sup>5</sup>	18 55 <sup>2</sup>	+1 <sup>8</sup>	— 0 <sup>9</sup>	— 2 <sup>6</sup>
	Altona 12 12 8 <sup>3</sup>	0 19 <sup>8</sup>	9 <sup>8</sup>	19 55 <sup>8</sup>	+0 <sup>2</sup>	—15 <sup>7</sup>	+ 9 <sup>5</sup>
	— 13 37 7 <sup>8</sup>	0 34 <sup>8</sup>	7 <sup>6</sup>	....	....	+ 6 <sup>7</sup>	....
3	Altona 9 52 25 <sup>3</sup>	....	....	28 50 <sup>7</sup>	+2 <sup>1</sup>	....	+ 0 <sup>3</sup>
	— 10 15 47 <sup>3</sup>	290 46 41 <sup>7</sup>	10 <sup>7</sup>	....	....	— 0 <sup>2</sup>	....
	Hamburg 10 37 3 <sup>7</sup>	47 30 <sup>5</sup>	10 <sup>8</sup>	29 13 <sup>9</sup>	+1 <sup>5</sup>	+20 <sup>0</sup>	+ 4 <sup>3</sup>
	Altona S. 11 48 37	46 45 <sup>3</sup>	10 <sup>3</sup>	29 42 <sup>7</sup>	+0 <sup>5</sup>	+21 <sup>7</sup>	+ 1 <sup>9</sup>

1850. May	M.T. at place. <sub>h m s</sub>	R.A. <sub>° ' "</sub>	Parall. <sub>"</sub>	North Decl. <sub>° ' "</sub>	Parall. <sub>"</sub>	Errors of Ephem.	
						$\Delta \alpha \cos \delta$	$\Delta \delta$
4	Hamburg	12 15 48 <sup>9</sup>	290 28 25 <sup>2</sup>	9 <sup>9</sup>	71 40 13 <sup>6</sup>	+0 <sup>0</sup>	+20 <sup>0</sup> +18 <sup>4</sup>
	Altona S.	12 54 43	26 18 <sup>5</sup>	7 <sup>2</sup>	40 4 <sup>0</sup>	-0 <sup>4</sup>	-9 <sup>3</sup> -8 <sup>0</sup>
5	Berlin	10 42 56 <sup>4</sup>	9 44 <sup>4</sup>	11 <sup>4</sup>	49 12 <sup>2</sup>	+1 <sup>2</sup>	+17 <sup>2</sup> +2 <sup>8</sup>
7	Altona	10 46 55 <sup>9</sup>	289 21 3 <sup>2</sup>	11 <sup>5</sup>	72 9 14 <sup>8</sup>	+1 <sup>0</sup>	-9 <sup>9</sup> +11 <sup>3</sup>
	Hamburg	10 56 17 <sup>0</sup>	20 28 <sup>2</sup>	11 <sup>4</sup>	9 12 <sup>0</sup>	+0 <sup>9</sup>	-17 <sup>6</sup> +4 <sup>6</sup>
8	—	10 13 50 <sup>8</sup>	288 55 29 <sup>8</sup>	11 <sup>8</sup>	18 43 <sup>6</sup>	+1 <sup>4</sup>	+7 <sup>7</sup> +9 <sup>7</sup>
	Altona	10 26 43 <sup>0</sup>	54 54 <sup>6</sup>	11 <sup>8</sup>	18 42 <sup>2</sup>	+1 <sup>2</sup>	+1 <sup>6</sup> +2 <sup>9</sup>
	Liverpool	12 34 20 <sup>4</sup>	52 17 <sup>6</sup>	9 <sup>9</sup>	20 1 <sup>6</sup>	+0 <sup>4</sup>	+15 <sup>1</sup> +13 <sup>9</sup>
9	—	10 55 45 <sup>0</sup>	24 13 <sup>7</sup>	11 <sup>9</sup>	28 49 <sup>9</sup>	-0 <sup>9</sup>	+11 <sup>5</sup> +4 <sup>4</sup>
10	Hamburg	11 35 16 <sup>3</sup>	287 53 8 <sup>3</sup>	11 <sup>2</sup>	38 46 <sup>8</sup>	0 <sup>0</sup>	+38 <sup>1</sup> +35 <sup>1</sup>
	Paris	11 7 18	50 30	13 <sup>0</sup>	38 17 <sup>1</sup>	+0 <sup>2</sup>	-8 <sup>5</sup> +4 <sup>6</sup>
11	Haverhill	10 8 42	15 49 <sup>5</sup>	12 <sup>9</sup>	47 6 <sup>7</sup>	+1 <sup>1</sup>	-17 <sup>8</sup> -2 <sup>4</sup>
12	Altona	10 27 47 <sup>2</sup>	....	....	56 11 <sup>8</sup>	+0 <sup>8</sup>	.... +6 <sup>1</sup>
	—	10 32 58 <sup>7</sup>	286 39 3 <sup>9</sup>	12 <sup>5</sup>	....	....	+1 <sup>1</sup> ....
	Hamburg	11 36 48 <sup>1</sup>	38 13 <sup>0</sup>	11 <sup>3</sup>	56 38 <sup>3</sup>	-0 <sup>2</sup>	+17 <sup>5</sup> +6 <sup>0</sup>
	London	10 57 35	38 36 <sup>8</sup>	12 <sup>8</sup>	56 35 <sup>7</sup>	+0 <sup>3</sup>	+24 <sup>3</sup> +3 <sup>6</sup>
	Liverpool	10 59 53 <sup>5</sup>	38 1 <sup>5</sup>	12 <sup>4</sup>	56 43 <sup>8</sup>	+0 <sup>5</sup>	+15 <sup>2</sup> +11 <sup>1</sup>
	Paris	12 33 56	33 24 <sup>0</sup>	10 <sup>5</sup>	57 26 <sup>6</sup>	-1 <sup>3</sup>	-24 <sup>4</sup> +20 <sup>6</sup>
13	Königsberg	10 53 36	285 58 36 <sup>2</sup>	12 <sup>0</sup>	73 5 5 <sup>2</sup>	+0 <sup>4</sup>	+3 <sup>7</sup> +15 <sup>2</sup>
	Altona	11 13 50 <sup>4</sup>	56 32 <sup>0</sup>	11 <sup>9</sup>	5 13 <sup>3</sup>	0 <sup>0</sup>	+0 <sup>1</sup> +0 <sup>2</sup>
	Hamburg	11 47 25 <sup>1</sup>	56 13 <sup>2</sup>	11 <sup>0</sup>	5 24 <sup>0</sup>	-0 <sup>5</sup>	+12 <sup>2</sup> -11 <sup>5</sup>
14	—	13 27 48 <sup>9</sup>	8 36 <sup>2</sup>	6 <sup>8</sup>	14 27 <sup>3</sup>	-1 <sup>7</sup>	+16 <sup>3</sup> -6 <sup>7</sup>
	Durham	13 20 54 <sup>8</sup>	8 40 <sup>2</sup>	7 <sup>3</sup>	14 57 <sup>4</sup>	-1 <sup>4</sup>	+35 <sup>7</sup> +12 <sup>2</sup>
	Liverpool	14 3 26 <sup>6</sup>	6 7 <sup>4</sup>	5 <sup>6</sup>	15 8 <sup>5</sup>	-1 <sup>9</sup>	+15 <sup>9</sup> +7 <sup>9</sup>
15	London	9 27 3	284 27 37 <sup>4</sup>	14 <sup>2</sup>	21 26 <sup>7</sup>	+1 <sup>4</sup>	+17 <sup>1</sup> -8 <sup>6</sup>
	Hamburg	10 54 0 <sup>9</sup>	26 20 <sup>3</sup>	12 <sup>5</sup>	21 45 <sup>3</sup>	+0 <sup>1</sup>	+23 <sup>2</sup> -7 <sup>1</sup>
18	—	11 36 0 <sup>4</sup>	281 40 49 <sup>2</sup>	11 <sup>3</sup>	44 30 <sup>3</sup>	-0 <sup>9</sup>	+21 <sup>7</sup> +3 <sup>4</sup>
	Haverhill	11 16 31	38 10 <sup>8</sup>	12 <sup>3</sup>	46 10 <sup>5</sup>	-0 <sup>8</sup>	-9 <sup>0</sup> +98 <sup>0</sup>
19	London	9 53 45	280 41 34	14 <sup>9</sup>	50 42	+0 <sup>4</sup>	+17 <sup>4</sup> +2 <sup>7</sup>
	Hamburg	12 23 13 <sup>0</sup>	36 54 <sup>0</sup>	9 <sup>0</sup>	51 3 <sup>2</sup>	-1 <sup>6</sup>	+22 <sup>0</sup> -6 <sup>5</sup>
20	London	10 36 23	279 34 57	13 <sup>9</sup>	56 48	-0 <sup>4</sup>	+30 <sup>3</sup> +0 <sup>3</sup>
	Hamburg	13 7 23 <sup>0</sup>	29 49 <sup>1</sup>	6 <sup>2</sup>	57 15 <sup>5</sup>	-2 <sup>1</sup>	+33 <sup>7</sup> +0 <sup>2</sup>
21	Liverpool	11 20 23 <sup>7</sup>	278 23 21 <sup>5</sup>	14 <sup>2</sup>	74 2 19 <sup>0</sup>	-0 <sup>8</sup>	+27 <sup>8</sup> +2 <sup>5</sup>
23	London	11 26 31	275 53 7 <sup>2</sup>	11 <sup>3</sup>	10 43 <sup>7</sup>	-1 <sup>6</sup>	+34 <sup>3</sup> -2 <sup>2</sup>
	Hamburg	12 19 21 <sup>6</sup>	52 39 <sup>3</sup>	7 <sup>7</sup>	10 36 <sup>9</sup>	-2 <sup>0</sup>	+39 <sup>3</sup> -11 <sup>2</sup>
25	—	11 14 0 <sup>7</sup>	273 11 14 <sup>3</sup>	10 <sup>8</sup>	15 35 <sup>4</sup>	-1 <sup>6</sup>	+40 <sup>7</sup> -12 <sup>4</sup>
	Altona S.	13 59 1 <sup>6</sup>	1 28 <sup>4</sup>	0 <sup>0</sup>	16 2 <sup>1</sup>	-2 <sup>6</sup>	+50 <sup>7</sup> -2 <sup>3</sup>
26	—	13 49 17	271 34 0 <sup>3</sup>	-0 <sup>0</sup>	16 54 <sup>8</sup>	-2 <sup>6</sup>	+62 <sup>3</sup> -5 <sup>0</sup>

The M.T. of observation is the M.T. of the place, except the English observations, where it is Mean Greenwich Time.

The *London* observations are those made at *South Villa* by MM. Bishop and Hind.

The column for Aberration is given by Mr. Schumacher, but is omitted here for want of room: it can easily be supplied from the ephemeris.

II. By Mr. N. Pogson, from observations on May 2, 9, and 15.

Perihelion Passage, 1850, July 23<sup>h</sup> 36<sup>m</sup> 19<sup>s</sup>.4, G.M.T.

$\alpha$ .....	273	20	11 <sup>h</sup> 4	} Mean Eq. May 0.
$\delta$ .....	92	55	6.1	
$i$ .....	68	9	16.3	
Log. $q$ .....	0.034241			

Motion direct.

III. By Mr. James Breen, Senior Assistant at the Cambridge Observatory. *From the Cambridge Observations* of May 11, 15, and 20.

Perihelion Passage July 22<sup>h</sup> 69<sup>m</sup> 40<sup>s</sup> Greenwich M.T.

Longitude of Perihelion	273	11	57 <sup>h</sup> 43	} Mean Eq. 1850, Jan. 1.
Longitude of Asc. Node	92	46	41.88	
Inclination	68	0	40.20	
Log. least distance	0.0330542			

Motion direct.

For the middle observation these elements give,

	Comp <sup>d</sup> —Obs <sup>d</sup>
$\Delta$ R.A. sin N.P.D.	= + 2 <sup>h</sup> 17
$\Delta$ N.P.D.	= - 0.40

EPHEMERIS OF PETERSEN'S COMET.

*Extract of a Letter from Professor Schumacher to the President.*

"From a consideration of the elements of this comet, as computed by M. Goetze and himself, M. Sonntag finds that it can probably be observed at the Cape, far into and perhaps through the month of September. He has calculated an *approximate* ephemeris, which is, however, sufficiently accurate for finding the comet. This I enclose, and beg that you will forward it as early as possible to Mr. Maclear. The ephemeris only reaches to August 22d, but Mr. Maclear will have no difficulty in continuing it with the co-ordinates which I have already sent you. M. Sonntag intends to extend the ephemeris, when a greater amplitude of observed arc has enabled him to obtain elements still more accurate. It is very desirable this comet should be observed after its perihelion passage. M. Gauss is even of opinion that it is not *proved* that a comet must, after having passed the perihelion, move in the same orbit as before."

*Ephemeris of Petersen's Comet*, calculated by M. Sonntag for  
Mean Greenwich Noon.

1850.	R.A.	Dec.	Log A.	1850.	R.A.	Dec.	Log A.
July 1	215 35	+48 51	9.7485	July 28	200 27	-20 26	
2	214 41	46 52		29	200 7	22 28	9.7527
3	213 49	44 48	9.7296	30	199 48	24 25	
4	212 59	42 38		31	199 30	26 16	9.7728
5	212 11	40 23	9.7121	Aug. 1	199 12	28 2	
6	211 25	38 1		2	198 55	29 44	9.7932
7	210 42	35 33	9.6996	3	198 39	31 21	
8	210 0	33 0		4	198 23	32 54	9.8137
9	209 20	30 22	9.6838	5	198 7	34 22	
10	208 42	27 40		6	197 52	35 47	9.8341
11	208 4	24 53	9.6743	7	197 37	37 7	
12	207 28	22 3		8	197 23	38 24	9.8541
13	206 54	19 10	9.6685	9	197 10	39 38	
14	206 21	16 16		10	196 57	40 49	9.8737
15	205 50	13 21	9.6668	11	196 45	41 57	
16	205 19	10 25		12	196 34	43 3	9.8928
17	204 50	7 31	9.6694	13	196 23	44 6	
18	204 22	4 38		14	196 12	45 6	9.9113
19	203 55	+ 1 48	9.6760	15	196 2	46 4	
20	203 29	- 0 59		16	195 52	47 0	9.9293
21	203 3	3 42	9.6863	17	195 42	47 54	
22	202 39	6 21		18	195 33	48 46	9.9466
23	202 15	8 56	9.6997	19	195 24	49 36	
24	201 52	11 25		20	195 16	50 25	9.9632
25	201 29	13 49	9.7157	21	195 8	51 12	
26	201 8	16 7		22	195 0	-51 58	9.9788
27	200 47	-18 19	9.7335				

*Opposition of Mars in 1849-1850, observed at the Cape of Good Hope.* By Mr. Maclear.

Date.	Name or No.	Cape Sid. T.	Excess of N. Declin. of Mars above N. Declin. of Star.	No. of Obs.
1849.		h m s		
Nov. 21	B. A. C. 2058	5 47 45.74	+ 10 3.402	4
	Geminor.	7 47 45.74	+ 0 53.618	4
22	—	7 13 0.94	+ 4 32.122	4
24	H. C. 11854	6 32 8.96	+ 5 21.681	4
25	H. C. 11946?	6 18 31.45	- 1 12.965	6
	Anon.	6 18 31.45	- 3 53.786	6
26	H. C. 11946?	6 53 40.72	+ 2 17.962	6

Date.	Name or No.	Cape Sid. T.	Excess of N. Declin. of Mars above N. Declin. of Star.		No. of Obs.
			h	m	
1849.					
27	H. C. 12336	6 4 18'30	—	4 38'208	14
28	— —	6 2 15'44	—	1 16'731	12
29	— —	6 55 30'81	+	2 10'416	6
30	— —	5 28 15'58	+	5 14'640	4
Dec. 1	H. C. 12395	6 2 55'97	+	4 22'948	5
2	— —	7 25 1'93	+	7 42'381	6
3	H. C. 11684	6 3 29'66	—	5 4'452	6
4	— —	6 1 40'38	—	2 5'716	8
5	— —	5 52 5'85	+	0 45'449	10
6	— —	6 9 45'87	+	3 33'647	20
7	— —	5 48 18'48	+	6 12'940	20
8	— —	6 13 26'43	+	8 45'818	20
9	— —	6 24 47'88	+	11 12'278	3
	139 Tauri	6 21 37'30	+	17 40'419	4
10	H. C. 11108	7 32 9'79	—	7 12'520	8
11	— —	6 24 39'74	—	5 11'326	3
14	— —	5 52 25'34	+	0 17'831	10
15	— —	5 32 6'06	+	1 47'944	10
16	— —	5 28 35'44	+	3 11'830	10
	— —	6 16 21'04	+	3 13'036	20
17	— —	6 26 8'30	+	4 25'652	20
18	— —	6 12 18'28	+	5 28'507	20
20	H. C. 10669	5 49 10'66	—	1 46'719	8
21	— —	6 34 13'76	—	1 10'850	8
22	— —	6 15 1'00	—	0 44'108	8
23	— —	5 29 48'99	—	0 25'759	2
24	— —	6 32 20'22	—	0 15'999	6
25	— —	5 8 26'05	—	0 14'143	10
	— —	5 38 42'35	—	0 14'649	10
26	— —	4 47 2'67	—	0 19'658	10
	Anon.	5 34 9'63	—	0 5'387	10
29	H. C. 10669	5 27 13'31	—	1 16'513	5
1850.					
Jan. 7	B. A. C. 1562	5 44 46'65	+	10 18'894	4
8	— —	5 59 5'12	+	9 16'948	4
9	— —	5 13 4'80	+	8 14'124	4
10	— —	5 18 14'70	+	7 11'623	4
11	— —	5 36 18'51	+	6 6'234	4
12	— —	5 45 44'58	+	5 0'751	4
14	— —	5 33 37'05	+	2 54'742	6
15	— —	5 9 40'33	—	1 52'874	6
16	— —	5 42 26'16	—	0 51'640	6
17	— —	5 13 34'02	—	0 5'839	7

The observations from which the foregoing results are deduced were made with the equatoreal instrument by Merz, of Munich, lately erected at the Cape Observatory, the telescope of which is about  $8\frac{1}{2}$  feet focal length. The differences of declination are measured by the micrometer.

All the details are given by Mr. Maclear; but as the especial object of the communication is to determine the parallax of *Mars*, in co-operation with observatories in the northern hemisphere, it has been thought sufficient to publish here what is required for correcting the tables of *Mars*.

*Occultation of Jupiter by the Moon (1850, May 19), observed at the Collegio Romano, Rome. By Professor Secchi.*

	Immersion. Sid. Time. h m s	Emersion. Sid. Time. h m s
3d Satellite	11 42 51.59	....
2d —	42 55.69	....
1st Limb Jupiter	43 12.69	12 39 31.29
2d —	45 18.49	41 16.89
1st Satellite	47 27.99	45 13.39
4th —	12 3 32.49	13 1 52.99

Observed by two observers with a Fraunhofer, 75<sup>mm</sup> aperture, power 70, and a Dollond, 46<sup>mm</sup> aperture, power 40.

Both observers agreed in the moments of immersion, which was very well seen. The outline of *Jupiter* remained perfectly round till the segment was very much reduced; the cusps then appeared enlarged, probably from the effect of irradiation.

The emersions are not so accordant. The weaker telescope showed the planet first. The assistant made some mistake about the minute in one instance. Altogether the moments of emersion are less trustworthy.

*Measures of  $\gamma$  Draconis.* By Mr. Fletcher.

The following values are the mean result of all the observations taken by Mr. Fletcher in the spring of 1850.\*

Position  $176^{\circ} 38'$  Distance  $2'' 953$  Epoch 1850.337

Capt. Shea has completed his drawings of spots on the sun up to June 13 (see *Monthly Notices*, vol. ix. p. 140 and 218; these are contained in the book presented to the Society), and also forwarded a sketch of the configuration of the moon, *Jupiter*, and *Regulus*, on the 19th May, 1850.

\* For a description of Mr. Fletcher's equatoreal and observatory, see *Monthly Notices*, vol. x. p. 137.

ERRATA.

In "Description of Mr. Fletcher's Observatory," p. 138, line 32, for  $1\frac{1}{2}$ -inch pine boarding, read  $\frac{1}{2}$ -inch pine boarding.

Page 142, line 13 from bottom, for  $+ 17^{\circ}$ , read  $+ 71^{\circ}$ .

## ROYAL ASTRONOMICAL SOCIETY.

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VOL. X.

June 14, 1850.

No. 8

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Rev. R. SHEEPHANKS, V.P., in the Chair.

Robert Grant, Esq., 5 Priory Villas, Islington;

Marcus Warburg, Esq., 29 Burton Street; and

Thomas Bowden, Esq., 51 Pall Mall;

were balloted for and duly elected Fellows of the Society.

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His Majesty the King of Hanover has granted the honorary gold medal for Art and Science to our Associate Dr. Rümker, director of the School of Navigation at Hamburg.

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### *Letter from Mr. Lassell to the Astronomer Royal.*

*"Starfield, 14 August, 1850.*

"My dear Sir, — I have strong reason to suspect that I have to-night detected a second satellite of *Neptune*.

"Last night, the 13th inst. at about 11<sup>h</sup>.0, I observed the satellite of *Neptune* for the first time this season, and made a diagram of it, the satellite being towards its *southern* elongation. The sky was extremely unfavourable; and finding that no measures of either position or distance could be taken with any chance of accuracy, I attempted none.

"To-night, in a somewhat better, but still bad sky, I see what I conceive to be *another* satellite, in the line of *northern* elongation of the old satellite, and about two diameters distant.

"This cannot well be the satellite already known, which ought to be almost preceding the planet, and in that position is generally invisible. There can be no question of the reality of the observations; the satellite of to-night (considerably fainter than that of last night) being repeatedly and almost constantly seen with various powers, *e.g.* 316, 479, 628. The position of the satellite is, as I have said, very nearly in the direction of the greatest northern elongation of the old one, and, being barely two diameters of the planet distant, may probably be interior to it.

"The sky became cloudy shortly after eleven and remained so, which prevented any confirmatory observations of motion. But I think the hypothesis of a fixed star of a similar magnitude and in the precise direction being located there, is too unlikely to throw much doubt upon the discovery."

*Extract of a Letter from Professor Hansen to the Astronomer Royal.**"Gotha, 1850, June 27.*

"The work on the Lunar Tables is advancing daily, but we have not yet gone so far as to enable me to communicate to you any result. In respect, however, to the moon's motion since the more distant ages, I am able to inform you, that an assistant, to whom I committed last year the task of comparing the ancient eclipses with the tables of the present day, has found, from the nineteen eclipses of the *Almagest*, a motion of the moon's node, which agrees in a remarkable manner with that which you have deduced from the *Greenwich Observations* from 1750 to 1830. According to his statement, he has found the correction of Damoiseau's secular motion of the node to be

$$+ 1'643,$$

while your investigations have given

$$+ 1'721,$$

a most surprising agreement. These corrections also agree with my theory as nearly as can be desired. Thus the view which Professor Seiffarth, of Leipzig, has explained, according to which a very important correction of the motion of the moon's node is deduced from the ancient eclipses, appears to be incorrect."

At the meeting of May 10, the President gave an oral account of a new arrangement of the double-image micrometer. Referring to a paper in the *Memoirs* of the Society, in which the general structure of the four-glass eye-piece, with the second lens (reckoning from the object-glass) divided, is described, and in which the equations of achromaticity are investigated, he showed that three equations only are given between seven quantities (namely, the four focal lengths of the lenses and the three intervals between them), and, therefore, that any four of the quantities may be assumed. This circumstance permits an infinity of different forms of solution. One form, which appeared generally convenient, was indicated in the memoir, and it has been found in practice to be perfectly successful as regards the special object of the theory, and to be subject only to two small practical inconveniences; that the field of view is rather contracted, and that a rather rapid screw is required for the micrometer, by which one-half of the divided lens is made to slide past the other. The President then stated that he had received a communication from Mr. Valz, of Marseilles, in which that gentleman had pointed out to him that the equations might be satisfied in a form which would give a larger field of view, by using for the divided glass a *concave* lens; and the President stated that he had immediately perceived that the construction would possess these two further advantages,—that a slower screw would suffice, and that, in consequence of the thinness of the

lens near the middle, very little light would be lost if the pencils of light were somewhat inclined to the axis of the telescope (the effect of the central thickness of a convex lens being that, if the pencils are at all inclined, a large proportion of the light is lost, more especially for the high magnifying powers.) The numbers which Mr. Valz pointed out are the following:—

Focal length of 1st lens, or that nearest the object-glass, arbitrary, or ...	<i>a</i>
Distance from 1st lens to 2d lens, the same as focal length of 1st lens, or	<i>a</i>
Focal length of 2d, or divided lens (which is concave) .....	1
Distance from 2d lens to 3d .....	1
Focal length of 3d, or field-glass .....	1
Distance from 3d to 4th .....	3
Focal length of 4th, or eye-glass .....	1

where the numbers 1 and 3 may be applied to any scale of linear measure whatever.

The next thing to be considered was the curvatures of the surfaces of the lenses. And here it is to be remarked that the accurate use of the double-image micrometer requires, both that the images be distinct, and that the images (considered as parts of the large image covering the whole field of view) be not distorted. The President had thought it probable that, for the higher powers, in which the pencils of light are very narrow, the first condition might be practically sacrificed to the second; but, upon trying surfaces which were better adapted to prevent distortion than to avoid indistinctness, the injurious effect on the definition was so striking, that he had determined to confine himself to the first condition. For securing this, the following rule is, in practice, sufficiently accurate:— Find, on one side of each lens, the place of intersection of the axes of pencils with the axis of the telescope; and on the other side, the place of intersection of the rays of light in a single pencil: if these are equidistant, the lens ought to be equiconvex: if the distances are unequal, the nearer of the two points ought to have the less convex surface. Applying this rule to the construction in question, the following are found to be proper forms:—

First lens, equiconvex.

Second, or divided lens, equiconcave (it is here nearly a matter of indifference).

Third, or field-glass, plano-convex, with its plane side next the divided lens.

Fourth, or eye-glass, equiconvex.

The eye-piece, constructed according to these rules, appears in practice to be excellent. Several change-lenses are provided for the first lens (their framing being so prepared that they necessarily take the proper distance from the divided lens), and in all the performance is extremely good. The images of stars are sensibly more round than those seen in the other constructions. There is no sensible distortion.

The eye-pieces, upon which the President's experiments have been made, were constructed from the numbers above given by Troughton and Simms.

## JUNO.

DURHAM.				Fraunhofer Equatoreal. (Mr. R. C. Carrington.)					
Greenwich M.T.				R.A.		Comp <sup>d</sup> —Obs <sup>d</sup> .	N.P.D.	Comp <sup>d</sup> —Obs <sup>d</sup> .	Set.
1880.	h	m	s	h	m	s	°	'	"
May 1	13	14	14.8	13	3	50.53	+3.15	86	25 15.6 +13.7 (1)
2	14	30	57.1		3	12.28	3.52	20	27.6 13.8 (2)
6	12	14	12.2	13	1	1.66	+2.74	86	4 22.1 +12.1 (3)

## Stars of comparison for Juno.

Name.	Ass <sup>d</sup> App <sup>d</sup> R.A.	No. of diff. taken.	Ass <sup>d</sup> App <sup>d</sup> N.P.D.	No. of diff.	Set.
	h m s		° ' "		
Weisse XIII. No. 62	13 4 46.46	12	86 32 58.5	4	(1)
B.A.C. 4456	13 7 57.17	12	86 9 24.0	4	(2)
Weisse XII. No. 1044	13 0 24 34	26	85 56 34.9	9	(3)

(Set 2.) The fourth set of comparisons was unfavourably made.

(Set 3.) Star too close for convenience.

The observations were taken with an eye-piece having five meridian wires and two moveable declination wires; the wires were faintly illuminated in a dark field.

The observations are corrected for refraction and parallax; the parallaxes and data for *Iris* being taken from the supplement to the *Nautical Almanac* for 1853.

## IRIS.

DURHAM.				Fraunhofer Equatoreal. (Mr. R. C. Carrington.)					
Greenwich M.T.				R.A.		Comp <sup>d</sup> —Obs <sup>d</sup> .	N.P.D.	Comp <sup>d</sup> —Obs <sup>d</sup> .	Set.
	h	m	s	h	m	s	°	'	"
May 4	14	38	19.7	15	44	36.56	+0.15	113	29 32.7 +5.3 (1)
5	13	42	41.2	15	43	41.72	+0.51	113	25 49.8 +2.3 (2)

## Stars of Comparison for Iris.

Name.	Ass <sup>d</sup> App <sup>d</sup> R.A.	No. of diff. taken.	Ass <sup>d</sup> App <sup>d</sup> N.P.D.	No. of diff.	Set.
	h m s		° ' "		
B.A.C. 5254	15 45 2.72	4	113 31 31.2	3	(1)
— —	15 45 2.73	15	113 31 31.3	5	(2)

(Set 1.) The planet and star were too close for the bisection to be made at time of right ascension measure. They were consequently taken alternately, and the north polar distance measures have been reduced to the time of the right ascension measures by the tabular hourly motion.

## HYGEIA.

LIVERPOOL.				Equatoreal.		(Mr. Hartnup.)			
Greenwich M.T.				R.A.		Comp <sup>d</sup> —Obs <sup>d</sup> .		N.P.D.	
1880.	h	m	s	h	m	s	°	'	"
July 17	13	3	19.3	19	11	13.82	112 16 29.2	— 9.93	+133.4
18	11	52	43.5	19	10	26.88	112 16 42.5	—10.02	+132.5
19	11	32	2.1	19	9	38.93	112 16 53.5	—10.32	+132.8
20	12	19	8.3	19	8	49.21	112 17 1.7	—10.61	+134.8

The observed places are corrected for refraction and parallax. The computed places were deduced from the ephemeris of M. d'Arrest, published in the *Monthly Notices*, vol. x. No. 7. It is supposed that the ephemeris is *not* corrected for aberration. It is also supposed that 10' should be added to the R.A. of July 21, 23, and 25.

The star of comparison for all the observations is  $\epsilon$  *Sagittarii*. The following is the assumed place derived from the Greenwich Twelve-year Catalogue.

For 1850.0.					
Mean R.A.			Mean N.P.D.		
h	m	s	°	'	''
19	0	50.33	111	15	24.25

## NEPTUNE.

## LIVERPOOL.

## Equatoreal.

(Mr. Hartnup.)

1850.	Greenwich M.T.			R.A.			N.P.D.			Comp <sup>d</sup> —Obs <sup>d</sup> .	
	h	m	s	h	m	s	°	'	''	R.A.	N.P.D.
August 3	12	56	27.1	22	33	27.44	99	56	15.2	+0.29	-0.6
5	11	52	29.6	33	16	76	57	21	3	0.23	0.8
6	12	6	27.7	22	33	11.17	99	57	55.7	+0.20	-0.7

The observed places are corrected for refraction and parallax.

The computed places were deduced from Mr. Sears C. Walker's ephemeris, published in the *Astronomische Nachrichten*, No. 721.

The stars of comparison on each day were B.A.C. 7840 and 7970. The following assumed places for 1850.0 are derived from the Greenwich Twelve-year Catalogue.

	Mean R.A.			Mean N.P.D.		
	h	m	s	°	'	''
B.A.C. 7840	22	22	42.20	101	26	37.2
— 7970	22	44	47.11	98	92	34.7

## FLORA.

## LIVERPOOL.

## Equatoreal.

(Mr. Hartnup.)

1850.	Greenwich M.T.			R.A.			N.P.D.			Star of Comparison.	
	h	m	s	h	m	s	°	'	''	B.A.C.	N.P.D.
August 6	13	16	40.2	0	35	34.15	94	37	38.45	145	—
	13	36	37.8			34.60			41.08	—	—
	13	56	35.4			34.98			43.98	—	—
	14	16	32.8	0	35	35.39	94	37	45.14	—	—

Corrected for refraction and parallax. Log  $\Delta$  taken from supplement to *Nautical Almanac* 1853.

Assumed place of star of comparison for 1850.0, derived from the Greenwich Twelve-year Catalogue.

	Mean R.A.			Mean N.P.D.		
	h	m	s	°	'	''
B.A.C. 145	0	27	31.67	94	25	9.76

## PETERSEN'S THIRD COMET.

WASHINGTON, U.S.      Equatoreal.      (Lieut. M. F. Maury.)

M.T. Washington,			Comet.—Star		Star of Comp.	No. of Obs.
1850.	h	m	R.A.	Dec.		
June 3	10	15 58.7	+7 0.86	+11 45.85	Groombridge 2418	5
	.....		6 5.57	4 57.32	—	2420 5
4	9	59 45.4	3 52.81	+ 2 12.00	—	2411 10
5	10	16 45.1	+3 49.28	—12 51.61	—	— 10

Apparent places of stars of comparison on days of observation.

	R.A.			N. Decl.		
	h	m	s	°	'	"
Groombridge 2411	16	59	21.32	73	21	15.99
— 2412	17	3	37.86	73	24	16.78
— 2420	17	4	33.24	73	31	6.89

The place of 2411 is from the Radcliffe Observations, 2418 and 2420 from observation with mural and meridian circle.

The observations are not corrected for refraction or parallax.

HAVERHILL.

(Mr. W. W. Boreham.)

Greenwich M.T.			R.A.		N.P.D.		Stars of Comparison.
1850.	h	m	h	m	°	'	
June 21	10	46 50	15 5	54.61 + p	26 57	11.1 + p	Arg. Z. 110, No. 12 and g
22	10	55 44	15 0	28.72	28 6	0.8	— 108, No. 66.
23	10	56 46	14 55	15.61	29 18	53.5	0.067 B.A.C. 4967.
24	10	55 27	50	12.34	30 36	14.4 + p	— 4918.
27	11	28 48	36	14.68	34 59	56.6 - p	Arg. Z. 5, No. 3.
29	10	37 32	28	12.30	38 18	39.4	0.126 — 1, No. 21.
July 1	10	10 37	20	40.81	42 0	0.1	0.172 — 113, No. 33.
2	10	56 52	17	2.68	44 6	44.7	0.268 — 111, No. 59.
5	10	20 7	7	19.38	50 40	39.8	0.175 Groomb. 2097, Rad. Obs.
7	10	14 28	14	1 27.80	55 35	19.6	0.463 H.C. 25975.
11	11	4 28	13	51 1.72	66 30	28.3	0.636 — 25637.
13	10	54 10	46	31.29	72 12	15.4	0.681 B.A.C. 4634.
15	9	54 26	13	42 18.70 + p	77 57	23.7 - p	0.701 Weissé xlii. 752.

Professor Smyth of the Royal Observatory, Edinburgh, has kindly observed the star H. C. 33239, 33244, and gives its mean place 1850.48, R.A.  $17^h 55^m 50^s.68$ ; N.P.D.  $15^{\circ} 24' 29''$ . 1, a small correction will therefore be required to be applied to my observation of May 28.

The observation of June 11, given in the previous number, should stand thus, N.P.D.  $19^{\circ} 6' 8''$ . 1 + p 0.306.

June 21: g is the star compared with; this precedes Arg. Z. 110, No. 112,  $1^m 46^s.35$ , and is north of it  $3' 17''$ . 1.

All the observations after July 2 are corrected for refraction, before this date the position of the comet rendered the correction inappreciable.

DURHAM. Fraunhofer Equatoreal. (Mr. R. C. Carrington.)

1868.	Greenwich M.T.			R.A.			N.P.D.			Set.
	h	m	s	h	m	s	°	'	"	
June 4	11	54	21.6	17	4	17.71	-0°014	p	16 34 20.0	+0.319 p (8)
7	13	24	19.6	16	40	45.73	+0.055	p	17 26 11.7	0.255 p (9)
13	12	23	55.6	15	56	19.92	0.051	p	20 15 6.2	0.201 p (10)
15	12	19	10.0	42	25	9.1	0.055	p	21 35 0.1	+0.159 p (11)
19	13	17	29.5	16	45	35	0.076	p	24 59 33.4	-0.055 p (12)
20	12	28	2.5	15	11	8.07	0.064	p	25 57 43.5	+0.002 p (13)
22	12	38	30.3	14	59	33.44	0.066	p	28 11 8.0	-0.085 p (14)
24	12	47	12.5	49	50	68	0.066	p	30 42 23.8	0.171 p (15)
	13	21	27.5	49	43	96	0.071	p	44 13.9	0.240 p (16)
26	13	43	11.2	40	18	33	0.068	p	33 36 20.6	0.358 p (17)
27	13	28	36.2	35	58	07	0.065	p	35 8 29.1	0.365 p (18)
28	13	49	9.2	31	42	12	0.064	p	36 48 26.7	0.444 p (19)
29	12	46	1.4	27	51	44	0.059	p	38 27 55.7	0.357 p (20)
July 1	12	43	31.7	20	19	18	0.055	p	42 12 12.4	0.427 p (21)
3	11	25	6.7	13	33	60	0.045	p	46 14 50.9	0.374 p (22)
4	11	35	25.9	10	18	23	0.046	p	48 29 2.7	0.431 p (23)
5	11	45	51.6	14	7	7.19	0.046	p	50 49 22.8	0.486 p (24)
9	10	56	32.7	13	56	0.41	0.039	p	60 55 59.3	0.575 p (25)
10	13	31	18.1	53	11	96	0.042	p	63 58 52.5	0.781 p (26)
13	11	57	54.8	46	22	52	0.040	p	72 21 46.0	0.753 p (27)
15	11	20	36.1	13	42	11.83	+0.038	p	78 8 7.4	-0.786 p (28)

Stars of Comparison.		Assumed Apparent Places.		No. of Diff. obsd.	
		R.A.	N.P.D.	R.A.	N.P.D.
		h m s	° ' "		
B.A.C. 5769		16 59 21.63	16 38 44.1	5	1 (8)
Argelander, Zone 124, No. 17		16 38 42.14	17 19 42.8	3	1 (9)
— 116, No. 133		15 54 24.98	20 6 4.1	6	6 (10)
Unknown. See Notes.		15 44 40.16	21 22 18.3	19	4 (11)
— —		15 6 16.21	24 52 44.5	10	2 (12)
Argelander, Zone 112, No. 91		15 9 8.29	25 48 41.2	23	5 (13)
— 108, Mean of Nos. 64 and 66		14 55 23.09	28 18 18.2	15	3 (14)
Unknown. See Notes.		14 45 51.20	30 32 51.1	25	5 (15)
Perhaps Arg. Zone 7, No. 26. See Notes.		14 53 30.46	30 51 55.0	9	2 (16)
Argelander, Zone 5, No. 29		14 35 5.75	33 38 44.9	15	3 (17)
B.A.C. 4845		14 33 31.25	35 19 23.2	30	6 (18)
Unknown. See Notes.		14 36 30.12	36 42 19.6	10	2 (19)
Argelander, Zone 1, No. 22		14 26 42.14	38 18 41.1	28	6 (20)
— 113, No. 33		14 23 26.42	42 9 46.5	32	7 (21)
Unknown. See Notes.		14 16 39.74	46 6 2.6	25	5 (22)
— —		14 17 44.50	48 28 9.0	23	5 (23)
Lalande 25924		14 0 8.09	50 51 43.0	28	6 (24)
— 25780		13 54 33.94	60 51 39.5	40	8 (25)
— 25610		13 47 29.88	64 3 0.5	12	3 (26)
B.A.C. 4634		13 45 21.09	72 31 16.5	30	8 (27)
Unknown. See Notes.		13 46 34.95	78 11 36.7	15	5 (28)

Since the 4th of June a wire micrometer with 5 transit wires and 2 moveable declination wires has been used; previously a bar-micrometer. A succession of sea-fogs and cloudy weather prevented following the comet further. The observations are corrected for refraction. The factors for parallax are given,  $p$  being the E. H. parallax in *arc* in both cases. It will be understood that the places of the stars mentioned below are only roughly approximate. Whatever correction may be found to be required by the star must be applied to the comet. Most of the Argelander-stars have been checked by comparison with one or more neighbouring stars.

(Set 9.) The star was not identified on the night of observation, the weather not allowing time.

(10.) Taken on a boisterous night by the help of a hearing tube; the telescope somewhat in vibration.

(11.) The star was the first preceding of a group of five. The second followed in  $1^m 13^s.6$ , and was Argelander Z. 116, No. 124.

(12.) The star was preceded by another by  $70''$ , and by  $10'.5$  more N. Its place depends on Argelander Z. 112, Nos. 82 and 83.

(14.) Mean taken. The two places in Argelander very discordant.

(15.) The star was preceded by another by  $1^m 23^s.2$ , and by  $5'.0$  more N. Its place depends on Argelander Z. 7, Nos. 11 and 15.

(16.) The star's place depends on Argelander Z. 7, Nos. 21, 23, and 28. It was the s. p. star of an open double; both of  $9^{th}$  magnitude. I could not recognise Argelander Z. 7, No. 26 $\frac{1}{2}$ , probably it was the star used, its declination being supposed  $40''$  in error.

(18.) The minutes of declination of Argelander Z. 5, No. 26, should be  $42'$ , not  $32'$ ; it is then B.A.C. 4845, the star used.

(19.) The star was of 8th magnitude; its place depends on Argelander Z. 1, No. 38.

(22.) Star depends on Lalande 26358. No. 26582 appears to be about  $50''$  in error: right ascension *too great* by that amount.

(23.) The star's place depends on Lalande 25937, and through intermediate stars on B.A.C. 4728. Lalande 26041 appears to be  $35''$  erroneous in right ascension.

(24.) Lalande 25924 and 25925 are identical; the decimal point of the seconds of north polar distance of the latter is misplaced. The mean right ascension of the two appears nearly  $2''$  too great. Before adopting the above place, I compared the star with B.A.C. 4783, and  $\gamma$  Boötis.

(28.) The star is neither in Bessel or Weisse; it was of 9th magnitude; its place depends on Weisse XIII., Nos. 824 and 995.

#### Size of the Comet, observed at Durham.

"The state of the atmosphere being very favourable on June 29, a few measures of the extreme diameter of the nebulousity of the comet in the north and south direction were made. The mean result was  $2' 6''.3$  on June 29, at  $12^h 54^m$  Green. M.T.

"This, reduced approximately by the value of  $\log \Delta$  given in D'Arrest's Ephemeris, makes the total diameter of the comet in this direction a little more than four times that of the earth. So far as I could get any impression of the comet's form, I should say it was somewhat elongated in the south-south-following direction, but this was doubtful.

"This was the only night at Durham on which the comet appeared backed by a dark ground: on all other occasions the nebulousity shaded off into the white vapour in the sky. Single measures of the size were made also on June 24 and July 9. They give values a little less than the one above, as was to be expected for the reason stated."

LIVERPOOL.				Equatoreal.				(Mr. Hartnup.)			
Greenwich M.T.				E.A.				N.P.D.			
1850.	h	m	s	h	m	s		°	'	"	Star of Comp.
June 22	12	27	53.1	15	0	7.12		28	10	36.8	5097 B.A.C.
	26	12	15 35.7	14	40	35.84		33	30	44.6	♄ Boötis

The values of the factors for parallax are,—

June 22				Log $\frac{p}{P} = +8.8071$				Log $\frac{q}{P} = -8.4356$			
26				= +8.7720				= -9.1956			
July 4	10	58	2.2	14	10	22.60		48	25	30.2	4812 B.A.C.
	7	12	0 56.5	14	1	16.73		55	46	27.9	4808 —
	9	12	27 34.0	13	55	51.52		61	6	14.8	4640 —
	13	12	17 22.8	13	46	19.63		72	24	8.7	4597 —
	14	11	57 52.7	13	44	14.25		75	16	54.2	(a)
	16	10	28 38.2	13	40	16.95		80	56	42.4	(b)
	18	10	43 1.3	13	36	28.36		86	49	9.4	4529 B.A.C.
	19	10	34 20.7	13	34	41.56		89	32	10.3	4532 —

The observations in July are corrected for parallax.

The log  $\Delta$  is taken from M. Sonntag's ephemeris, published in the *Monthly Notices*, vol. x. No. 7.

The following are the assumed places of the stars of comparison for 1850.0.

	Mean R.A.			Mean N.P.D.			Authority.	
	h	m	s	°	'	"		
B.A.C. 5097	15	21	35.96	30	30	24.76	Green.	12-year Cat.
♄ Boötis	14	20	5.30	37	27	15.15	—	— —
B.A.C. 4812	14	26	2.20	51	2	0.72	—	— —
— 4808	14	25	21.85	58	58	4.24	—	— —
— 4640	13	46	22.25	60	36	45.90	B.A.C.	
— 4597	13	40	8.04	71	47	36.96	Green.	12-year Cat.
(a)	13	48	36.51	75	12	24.81	Comp <sup>d</sup> with 1086, 1147 of Green. 12-year Cat.	
(b)	13	42	17.42	80	50	38.48		
B.A.C. 4529	13	26	31.87	85	34	7.70	Green.	12-year Cat.
— 4532	13	27	3.25	89	49	38.07	—	— —

*Elements of Petersen's Third Comet.* Calculated by Dr. Petersen and M. Richard Schumacher, May 4, June 6, July 9.

T. 1850, July 23.52220 Greenwich M.T.

$\pi$ .....	273	24	20.5	} Mean Eq. 1850.0.
$\delta$ .....	92	53	1.5	
$i$ .....	68	12	12.5	
Log. $q$ .....	0.0340197			

Direct.

"It has been impossible to represent the middle observation closer than to 7" in longitude and latitude, but the difference is too small to warrant the conclusion that this is a sign of ellipticity."

*Ephemeris of Petersen's Comet for 0<sup>b</sup> M.T. Berlin.\**  
By M. R. Schumacher.

	R.A.	S. Decl.	Log. A.	Log. r.
Sept. 21	194 46	68 44	0·1545	0·1594
25	195 16	70 34	0·1712	0·1715
29	195 56	72 23	0·1869	0·1837
Oct. 3	196 48	74 11	0·2015	0·1957
7	197 50	75 59	0·2153	0·2076
11	199 9	77 47	0·2282	0·2194
15	200 52	79 35	0·2405	0·2310
19	203 9	81 24	0·2522	0·2424
23	206 28	83 13	0·2634	0·2536
27	211 54	85 2	0·2740	0·2646
31	222 48	86 47	0·2843	0·2753

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*On a Method of finding the Effect of the Difference of Parallax, at different Places, upon the Time of Disappearance and Reappearance of a Star occulted by the Moon.* By the Rev. Temple Chevallier.

The author treats the theory of occultations by supposing a line to be drawn from the centre of the earth to the star, and drawing a plane perpendicular to this line, and projecting upon this plane the disk of the moon and the place of the point of observation on the earth at the instant of disappearance or reappearance at one station: the position of the place being defined by rectangular co-ordinates, and the form of the projection of disk being defined by an equation between rectangular co-ordinates. At the station for which the occultation has been computed the co-ordinates satisfy that equation, or the projection of that station is on the circumference of the circle which is the projection of the moon. For another station the projection is not on the circumference of the circle, and the difference of the absolute times of occultation will depend on the distance of its projection from the circle. The author then has recourse to a graphical method: he lays down, by means of the elements in the *Nautical Almanac*, the places of the star on the moon's limb at disappearance and reappearance; by applying to these the computed differences of projections of the two stations, he obtains the apparent positions of the star at the same instants, as seen from the other station; then joining these by a straight line, and assuming that the apparent path of the star will

\* An ephemeris for the same time, but with earlier elements, was calculated by M. Sonntag, and sent some weeks ago by Professor Schumacher to the *Astronomer Royal* for Mr. Maclear's use.

be in that line, and will be described with a uniform velocity such as would carry it between the *Nautical Almanac* places of disappearance and reappearance in the *Nautical Almanac* duration, those parts of the straight line which are intercepted between the apparent positions of the star and the moon's limb serve for measures (approximately) of the time which must yet elapse before the phenomenon takes place, or which has elapsed since it took place, at the second station.

*On a Graphical Mode of Computing the Eccentric Anomaly.*

By J. J. Waterston, Esq.

The equation expressing the relation between eccentricity ( $e$ ), the mean anomaly  $\phi$ , and the difference between the mean and eccentric anomalies  $x$ , being  $x = e \sin (\phi + x)$ , or  $\sin (\phi + x) = \frac{x}{e}$ , Mr. Waterston graphically solves this equation by means of the curve of sines.

Having drawn this curve, the unknown ordinate is evidently a known multiple ( $\frac{1}{e}$ ) of the difference between the known abscissa ( $\phi$ ) and the unknown abscissa ( $\phi + x$ ). Hence it is found by drawing a line from the extremity of  $\phi$  inclined to the axis at an angle whose tangent is  $\frac{1}{e}$ .

The accuracy with which the value of  $\phi + x$  is determined will depend on the accuracy with which the curve is drawn, and also upon the scale to which it is drawn. If the radius be 8 inches it can with ease be read off to within 5'.

When a value of  $x$  has been obtained from the scale, it can be corrected by computation. Thus, since

$$e = \frac{x}{\sin (\phi + x)},$$

if the approximate value of  $x$ , determined from the scale, be substituted, an error of  $e$  will be obtained, and the corresponding error of  $x$  will be found by differentiating the equation with regard to  $x$ .

The author shows also how this correction may be obtained by a simple construction, and how the method of graphical projection may be applied conveniently in extreme cases, when the mean anomaly is small and the eccentricity great.

A diagram is annexed, exhibiting the curve and scales, with the construction for a given case.

*On the Limits of Error in the Elements of the Orbit of  $\alpha$  Centauri, and on the Orbits of  $\rho$  Eridani and 61 Cygni.* By Capt. W. S. Jacob, Astronomer at Madras. Communicated by Professor Piazzì Smyth.

The substance of these communications was received by Professor Smyth from Captain Jacob, in a series of private letters; and he has thought them of sufficient importance to induce him to collect together the results of the observations and deductions, and to present them to the Society.

*$\alpha$  Centauri.*

From observations, necessarily rough, made at Madras, Captain Jacob finds for  $\alpha$  Centauri, for the epoch 1849.63, the distance of the components  $36''.23$ , and the angle of position  $244^\circ.5$ , which renders probable a later perihelion passage, a less excentricity, and a less inclination, than had been previously assigned by him.

On examining all the observations of  $\alpha$  Centauri, available for the purpose between the years 1825 and 1849, the conclusion seems to be, that the annual motion in area is about two square seconds; but, on carrying this back to 1750, it cannot be accommodated to any ellipse whatever, so as to give a distance not exceeding  $.25''$ , and a position in the south preceding quadrant, unless a revolution be supposed to intervene.

The period is, therefore, limited to between 75 and 80 years, two revolutions in the interval being inadmissible; and the area of the apparent ellipse is thus limited to  $150''$  or  $160''$ . This being assumed, it is found that the greatest possible value of the minimum distance is about  $2''.5$ , and the latest possible time of nearest approach is 1854.

With regard to mass, the least possible value of the true semi-major axis is about  $11''.5$ , which corresponds to a mass of about  $0.325$ ; the excentricity being, however, indeterminate, the inclination and major axis may be very great. On the whole, the mass cannot differ very widely from that of the sun.

Captain Jacob has been enabled to arrive at some conclusion with regard to the quantity of light emitted by  $\alpha$  Centauri, from photometrical considerations by means of experiments on the distances at which the flashes from a heliotrope were visible with different apertures, made during his employment on the Trigonometrical Survey.

He found, after several years' observations, that for apertures of  $0.5$ ,  $1$ ,  $2$ ,  $4$ , and  $8$  inches, the limits of distance ultimately resulted  $15$ ,  $23$ ,  $33$ ,  $45$ , and  $60$  miles respectively.

This gives a rate of absorption which agrees pretty well with Professor Forbes' results given in the *Phil. Trans.* for 1842, vol. ii.

Applying these results to the intensity of solar light, the diameter of the object that shall be about as bright as *Venus*, is  $0.0205$  inch per mile, or subtends an arc of  $0''.0668$ . Making also due allowance for the circumstance that the object viewed was the reflexion of the sun from a metallic surface after passing twice through glass,

and assuming that the mean altitude of the sun for the times of observation may be taken to be about  $23^{\circ}$ , the portion of the zenith seen equal in brightness to *Venus* is  $0^{\circ}035$ .

Assuming also that the brightness of *Venus* is four times as great as that of *Sirius*, and that of *Sirius* four times as great as that of  $\alpha$  *Centauri*, the brightness of  $\alpha$  *Centauri* will be equivalent to a circular area of the sun's disk, whose diameter subtends an angle of  $0^{\circ}009$ , or the sun must be removed to 213333 times its present distance to have a brightness equal to that of  $\alpha$  *Centauri*. Its parallax must, therefore, be  $0^{\circ}97$ .

Captain Jacob earnestly recommends astronomers who have  $\alpha$  *Centauri* above their horizon to lose no time in commencing observations upon it.

*Orbit of p Eridani.*

This star is one of the quick-moving double stars, but the data are rather anomalous. All the observations found by Capt. Jacob are,—

Dunlop	1825.96	Position	$16^{\circ}54'$	Dist.	$2''5$
Herschel	1835.0	—	$122^{\circ}18'$	—	$3^{\circ}65'$
Jacob	1845.88	—	$186^{\circ}0'$	—	$4^{\circ}16'$
—	1846.83	—	$277^{\circ}0'$	—	$4^{\circ}32'$
—	1849.82	—	$270^{\circ}0'$		

Herschel's position should probably be  $302^{\circ}18'$ , and the first of Jacob's observations should, doubtless, have  $90^{\circ}$  added.

Captain Jacob computes an orbit from the above observations, of which the elements are,—

$$\begin{aligned} a &= 5''37 \\ e &= 0.454 \\ \pi &= 1^{\circ}30' \\ \Omega &= 295^{\circ}27' \\ \gamma &= 57^{\circ}24' \\ P &= 123 \text{ yrs.} \\ \tau &= 1827.08 \end{aligned}$$

but finding that these elements would give the distances of the stars for Dunlop's epoch only  $1''56$  instead of  $2''50$ , an error quite inadmissible, as the stars would then not have been separable by the telescope used, he assumes an error in Dunlop's position, and presumes that this should be  $163^{\circ}6'$  or  $343^{\circ}6'$ .

On this supposition, the following elements of the orbit result:—

$$\begin{aligned} a &= 4''25 \\ e &= 0.323 \\ \pi &= 36^{\circ}30' \\ \Omega &= 290^{\circ}40' \\ \gamma &= 46^{\circ}36' \\ P &= 107 \text{ yrs.} \\ \tau &= 1819.83 \end{aligned}$$

## 61 Cygni.

Captain Jacob supposes that this star will arrive at a minimum distance of  $17''$  or  $17''.5$  within the next 30 years; that the period is about 660 years; and that  $a = 21''$  or  $22''$ , and  $e =$  about  $0.25$ , the mass being not much inferior to that of the sun.

*Proper Motion of B.A.C. 535. By Mr. Johnson.*

In comparing the results of the Oxford Observations with those of other catalogues, the true proper motion of this star has been detected:—

*Right Ascension.*

B. A. C. 535 = B. F. 203 = P. I. 159 = Groombridge 376 = Taylor 571  
= Greenwich 12-Year, 150.

Piazzi	1800	R.A. = $1^{\text{h}} 33^{\text{m}} 26''.20$	Prec. = $+4''.104$
Groombridge	1810	34 8'.02	4''.114
Taylor	1835	35 54'.22	4''.138
Greenwich	1845	36 36'.12	4''.147
Oxford	1845	= $1^{\text{h}} 36^{\text{m}} 36''.05$	4''.147
—	1850	.....	+4''.152

The above reduced to 1850 by the Prec. due to the middle period, become

Piazzi	1850	R.A. = $1^{\text{h}} 36^{\text{m}} 52''.60$
Groombridge	—	53'.34
Taylor	—	56'.40
Greenwich	—	56'.87
Oxford	—	= $1^{\text{h}} 36^{\text{m}} 56''.80$

The mean epoch of the observations on which the Greenwich R.A. depends is 1843. The Oxford epoch is 1844. These R.A. compared with Piazzi's give an Annual Proper Motion =  $+0''.0974$ .

Applying the correction  $+0''.0974$  ( $1850 - t$ ),  $t$  being the epoch of the respective catalogues, we have

Piazzi	1850	R.A. = $1^{\text{h}} 36^{\text{m}} 57''.47$
Groombridge	—	57'.24
Taylor	—	57'.86
Greenwich	—	57'.55
Oxford	—	= $1^{\text{h}} 36^{\text{m}} 57''.38$

The mean of the above is  $1^{\text{h}} 36^{\text{m}} 57''.50$ . The R.A. of B.A.C. is  $1^{\text{h}} 36^{\text{m}} 52''.95$ .

Mr. Baily supposed that there was a mistake of one year's precession in Mr. Taylor's R.A. He was led to this supposition, apparently, by a mistake in the Madras catalogue, where the proper motion in R.A. is given =  $0''.009$ , instead of  $0''.09$ .

### North Polar Distance.

	N.P.D.	Prec.	N.P.D.
Piazzani 1800	= 27° 8' 32" 7	— 18° 41	1850 = 26 53 15·2
Groomb. 1810	27 5 31·2	18° 39	— 17·6
Taylor 1835	26 57 56·9	18° 33	— 25·5
Greenw. 1845	26 54 55·8	18° 30	— 24·3
Oxford 1845	= 26 54 56·7	18° 30	— 26 53 25·2
— 1850	.....	— 18° 29	

The mean epoch of the Greenwich observations is 1843. The Oxford epoch is also 1843. Comparing these N.P.D. with Piazzi's, there appears to be an Annual Proper Motion in N.P.D. =  $+0^{\circ}.22$ .

Correcting the above N.P.D. for 1850 by  $+0^{\text{m}}.22$  (1850- $\theta$ ), we have

Piazz	1850	N.P.D. =	26° 53' 26.2"
Groombridge	—		26.4
Taylor	—		25.5
Greenwich	—		25.8
Oxford	—		26 53 26.7

**The Madras Catalogue makes the Proper Motion in N.P.D. = +0.19**

The B.A.C. " " = +0'14

*Letter from Lord Wrottesley.*

“ On the 1st of January last, I commenced observing a new catalogue of the right ascensions of small stars, selected from the B.A.C. The catalogue, when complete, will contain above 1000 stars of the 6th and 7th magnitudes, chosen from among those which have either great proper motion or have been inadequately observed. It is a curious coincidence that the Madras Observatory, which was before engaged contemporaneously with myself on a similar task, has again entered upon the same field of inquiry; and I cannot do better than imitate the example of the Madras Astronomer, by communicating to the Royal Astronomical Society from time to time those stars whose places differ materially from the catalogue already referred to.

"In all these cases, care has been taken to search diligently for the true star; but none could be found nearer to the place given in the catalogue. It is my intention to observe each star at least five times, and therefore it will be understood that the observations of some of the objects in the accompanying list are not yet finished.

"The observations are made with the 5-foot transit and clock described in the tenth volume of the *Royal Astronomical Society's Memoirs*, set up in a fixed observatory, the place of which is given in the *Nautical Almanac for 1852, et seq.*; but the detailed description of which I may postpone till the catalogue is completed."

*List of Stars in the B. A. Catalogue already observed, in which the Right Ascension differs by more than One Second in Time from that Catalogue.*

B.A.C.	Excess of Observed Mean Place above B.A.C.	No. of Obs.	B.A.C.	Excess of Observed Mean Place above B.A.C.	No. of Obs.
1826	+ 1'16	6	4652	+ 28'97	5
1907	— 5'18	7	4682	+ 1'21	5
2070	— 1'06	2	4723	— 1'43	5
2488	+ 1'30	3	4776	— 1'34	5
3086	— 1'55	2	4920	— 1'34	4
3233	— 60'71	2	5091	— 1'02	4
3627	+ 1'46	5	5527	+ 1'87	2
4199	+ 1'63	5			

*Micrometrical Measurements of Double Stars, made at Ormskirk between 1834.0 and 1839.4. By W. R. Dawes.*

“The observations which I have now the honour of presenting to the Society were made partly with the 5-foot equatorially-mounted achromatic telescope employed in procuring the results published in the eighth volume of the *Memoirs*, and partly with a Newtonian reflector having a focus of about seven feet and an aperture of six and a quarter inches. The large mirror and the small plane mirror of this telescope were presented to me by Sir John Herschel during my visit to him at Slough in the autumn of 1833, previous to his departure for the Cape of Good Hope. These metals were mounted for me by Mr. Dollond, so as to be applied to the polar axis of my 5-foot achromatic, and to supply the place of the counterpoise to the telescope and declination-circle in that mounting. The motion in polar distance was produced by means of two brass circles, about two feet in diameter, one of which was firmly attached to the polar axis, and the other to the tube of the reflector; the circles being united at their centres, and fixable by a clamp at any required polar distance. A small setting-circle with a level was attached to the outer side of the tube, whose vernier read to one minute. This mounting was found to be sufficiently steady, in tolerably calm weather, to allow of satisfactory measures with the micrometer; and, as far as I know, it was the *first* successful attempt to give to a Newtonian reflector a universal equatoreal motion suitable to the delicate micrometrical measurements of double stars.

“The large metal was cast and originally figured by Sir William Herschel; but the surface having become greatly tarnished, it was repolished by Sir John, shortly before he presented it to me. Its figure was sufficiently good to give a neat round disk to a star; and from its *larger aperture*, its *separating power*

considerably exceeded that of the 5-foot achromatic: so that on tolerably bright and very close double stars, such as  $\gamma$  *Virginis* at that period, and  $\lambda$  *Ophiuchi* (then much closer than at present), its superiority was unquestionable. Unfortunately, it soon lost so large a portion of its lustre that its illuminating power became inferior to that of the 5-foot refractor. It was also much less certain and uniform in its action, though a great variety of expedients were resorted to in hopes of overcoming this annoying defect; some of which were productive of advantage, though not to the extent of rendering it as uniform in its action as the refractor. By Sir John Herschel's recommendation it was bedded in its box on folds of flannel, the edge of the metal also resting on the same soft and elastic substance. The effect of friction on its edge being, however, still too obvious, I substituted for the flannel a piece of strong tape, supporting the metal as in a sling, and permitting it without obstruction to take an equal bearing against the flannel at the back. This I found to be a decided improvement; and Mr. Lassell, having recently adopted a similar plan in the mounting of his 9-inch and 24-inch metals, also bears testimony to its great utility. As, however, a telescope requires for its perfect action that the state of the air should be good in a degree proportioned to the area of the object-glass or metal, vision was usually, on most objects, best in the refractor; and even in the finest states of the atmosphere the reflector did not always answer the reasonable expectations of the observer; and much precious starlight was frequently lost in vain attempts either to discover or remove the cause of its distress. This circumstance, combined with its rapid loss of lustre, caused the reflector to be but little employed during the latter part of the period embraced by these observations.

"In the measurement of very minute stars, the achromatic concave lens, mentioned in my former communication, has been very generally employed. As the construction and use of this valuable appendage has not, I believe, been described in any paper presented to this Society, it may be proper to refer to it here more particularly. The lens is fully described in a paper by Mr. Dollond, which was read before the Royal Society in February 1834; into which paper were introduced a letter from myself to Mr. Dollond, stating the advantages of its application to the micrometer, and also a letter to Mr. Dollond from Professor Barlow, the inventor of the lens, detailing the formulæ according to which it was constructed. Mr. Dollond says in the paper alluded to, 'I do not wish to take credit to myself for anything like an invention, but merely for the application of the lens to the micrometer, as I am fully convinced that a concave lens, either simple or achromatic, was never so applied before.' In referring to this achromatic concave lens, in the notes appended to these observations, I have therefore termed it '*the BARLOW lens*,' by which name justice is done to its inventor. In Mr. Dollond's valuable application of it to micrometrical purposes, it is introduced, by the tube in which it is mounted, into the main tube of the telescope, so as to intercept

the rays transmitted by the object-glass before they come to focus: The focal image is thrown a few inches further from the object-glass than it otherwise would be, and it is proportionably *enlarged*. By a variation of the distance between the object-glass and the Barlow lens, the degree of enlargement is altered; and thus that amplification of the image can be fixed upon which best suits the purpose of the observer. The lens Mr. Dollond constructed for me was mounted in a piece of tube, of such a length that when screwed into the telescope it rather more than doubled the diameter of the focal image: and this proportion appeared to be generally the most useful.

"The advantages attending the use of the Barlow-lens may be *comparatively* summed up as follows:—

"1. The diameter of the micrometer-threads subtends only about half the angle: small stars are, therefore, neither obliterated nor distorted by them.

"2. The moveable parallel threads are *both as nearly in focus*, with double the magnifying power. This is a most important matter in the measurement of distance. As the parallel spider's lines must pass each other freely, they must move in different planes, and at different distances from the eye-piece. Consequently, when high powers are produced in the ordinary way on a telescope of the usual proportions (the power being, for instance, more than five or six times the focal length, expressed in inches), there is an obvious indistinctness in one of the threads when the other is accurately in focus. This defect is nearly got rid of by the use of the Barlow-lens.

"3. The value of the micrometer divisions with the Barlow-lens is only about half of its amount without it; permitting a proportionably fine motion in the measurement of distance.

"4. With any given magnifying power, the threads are distinct to a much greater distance from the centre of the field; the eye-piece producing the power having double the focal length.

"5. The eye-pieces of greater focal length are much more easily cleaned than those of less; of great importance in high powers especially.

"6. The small reflecting *prism* interposed between the eye-piece and the eye can be advantageously employed with double the magnifying power on the telescope. This extension of its utility is of great value.

"As a set-off against the important advantages above enumerated, it must be acknowledged that the application of the lens increases the length of the telescope by a few inches, and also that it is requisite to determine the value of the micrometer-screw with the lens attached to the telescope, as well as without it. Neither of these objections, however, is of much practical importance. One of more weight is the greater illumination of the field, which is requisite to render the very fine spider's lines sufficiently visible. For this, the most efficient remedy (in addition to the *deep red* illumination) is an increase of magnifying power. By this means the apparent diameter of the threads is augmented *in proportion to the power*,

while the brightness of the field is *diminished* in the *duplicate ratio* of the increase of power. It is important to notice that the brilliancy or vividness of a *fixed star* is *not* diminished in the same proportion, though it is usually assumed to be so. To an object of sensible diameter, as a planet, such reasoning is applicable, but not to a fixed star, the apparent diameter of whose telescopic disk is *not* increased in proportion to the power employed.

"The spider's lines, when thus attenuated by the use of the Barlow-lens, are too fine for use in observing angles of position; my own eye, at least, is dissatisfied with them, as not possessing sufficient substance for the judgment to lean upon. I, therefore, had two pretty thick parallel metallic wires fixed into the micrometer-plate, which formerly held a single spider's line at right angles to the moveable parallel threads, and intended for measures of position. The diameter of each wire subtended an angle of about 4", and the inner edges were placed about 7" or 8" apart. Their visibility with feeble illumination of the field extended the power of the telescope, in measuring angles of position, to stars of fully one magnitude lower. Their perfect parallelism was proved by stars rolling along the inner edge of both with the same setting of the position-circle.

"In the *Introduction* to my former double-star observations, I adverted to the importance of placing the stars parallel to a principal section of the eye; so that they should appear in the telescope nearly vertical or nearly horizontal. Further experience has even more fully convinced me of the necessity for this. When the obliquity of the star's position is not more than  $20^\circ$  or  $30^\circ$ , a corresponding inclination of the observer's head may answer the purpose without introducing an inconvenient posture. When, however, the angle of position lies between  $30^\circ$  and  $60^\circ$  from the meridian, the use of the reflecting prism attached to the eye-piece renders it easy to adapt the apparent position of the stars to the observer's convenience. By the help of this valuable little appendage, many of the stars in the following catalogue were observed both in an apparently vertical and horizontal position, in order, as much as possible, to destroy all bias of the judgment."

We have selected from Mr. Dawes' paper some notices of remarkable stars.

$\gamma$  Ceti.  $\Sigma$  299. Mr. Dawes gives the angles of positions by several observers, and considers that the agreement between the angles of the same observer, and the discrepancies between different observers, seem to show somewhat of a *personal equation*. The observations make the binary character of the star probable, but do not prove it to be so indubitably.

Castor.  $\Sigma$  1110. "My observations of this star since 1833 do not confirm the orbit predicted by Sir John Herschel (*Mem. Ast. Soc.* vol. v. p. 203). The distance is still increasing, and is now fully 5".

$\gamma$  Virginis.  $\Sigma$  1670. "The angle I obtained in 1834 being the result of eight nights' observation is probably entitled to some consideration, although the distance was only about 0".9."

44 *Boötis*.  $\Sigma$  1909. "The observations of this star show a continued augmentation of the distance, with a very slight increase in the angle of position."

$\xi$  *Scorpii* (=  $\xi$  *Librae* = 51 *Librae*).  $\Sigma$  1998. "The variation of the angle of position of these stars in a direct sense is supported by the observations given in the following catalogue. Combined with my observations for 1833 contained in my previous paper, we have,

1833.39	P = 6.20	D = 1.15	by 1 night's obs.		
1834.50	7.12	1.166	— 4 — —		
1836.49	9.53	...	— 1 — —		

In the *Phil. Trans.* for 1785, the position is given by Herschel I. as  $82^{\circ} 2'$  north following, or  $7^{\circ} 58'$  in the notation now used. As, however, the stars are almost exactly equal, it seems highly probable that, to compare it with the more modern observations, the position should be increased by  $180^{\circ}$ . Instead, therefore, of a *whole* revolution having been performed since 1782, it is most likely that only about  $197^{\circ} 5'$  have been passed over. The apparent distance seems to have varied but little. The angle of position at the present time (1850) is about  $31^{\circ}$ ."

*Cephei* 83.  $\Sigma$  2751. "A diminution of distance in these stars is probable, while the variation in position, if any, is so small as to be completely masked by the errors of observation."

*Pegasi* 29.  $\Sigma$  2804. "This object was supposed by Sir John Herschel to be in rather rapid rotation, from a comparison of his own measures with each other, and with those taken by Sir James South in 1826. It is remarkable that Struve arrived at the same conclusion from comparing together his own observations during six years, which show a pretty regular increase of nearly  $5^{\circ}$  in that time. The measures which I have obtained, however, do not bear out so rapid a motion, even if there be any; and Struve's re-examination of the star led him to reject the supposition of change. My observations at two different epochs are as follows:—

1832.87	P = $314^{\circ} 17'$	D = $3'' 12$	by 1 night's obs.		
1835.44	$317^{\circ} 00'$	$3'' 18$	by 3 — —		

"Notwithstanding the trouble which this star has already given, it is desirable that it should be still further examined, as it may be questioned whether its real nature is even yet determined."

$\zeta$  *Aquarii*.  $\Sigma$  2909. "The retrograde motion of these stars is distinctly shown by the observations here recorded.

"A diminution of distance may be suspected, though it must be acknowledged that my earlier measures of distance were generally too large."

$\Sigma$  3061. "The change which Sir John Herschel suspected was going on in this star is by no means supported by my observations.

"It is worthy of remark that in this case, as in most others in which extraordinary changes of angle have been deduced from erroneous observations, the position of the stars is very *oblique* to the

meridian; and it is probable that, in the earlier measurements, no peculiar precautions were adopted on that account."

The catalogue then follows, and consists of 627 entries (many of these relate to the same star), containing the name of the star, Struve's number, the approximate right ascension and north polar distance for 1840, the angle of position and distance, with the number of observations, the weight of the result, and the magnifying powers employed. Finally, are set down the magnitudes of the component stars and the epoch at which the measures were made.

*On the Longitude and Latitude of the Observatory, George Town College, near Washington. and the Situation of some Leading Points in that City.* By Mr. Curley.

"The latitude of our Observatory is deduced from 7 observations of *Polaris* above and below pole, 7 observations of  $\alpha$  *Ursæ Majoris* above and below pole, 7 observations of  $\lambda$  *Ursæ Minoris*, using the *Nautical Almanac* declination, and 180 observations of other stars. The mean of these accordant observations gives the latitude of George-Town College Observatory  $38^{\circ} 54' 26''$  North.

"The instrument with which the observations were made is a meridian transit circle by Simms, with a divided circle of 45 inches diameter, read off by four microscopes. The telescope is of 5 feet focus and 4 inches aperture. The nadir point was found by viewing the wires reflected from a surface of mercury.

"The longitude from Greenwich is deduced from four corresponding lunar transits made at Greenwich and George Town, with all the seven wires. The Astronomer Royal very kindly sent the observations immediately on request. There were more corresponding observations, but as some of the wires were wanting, and as the mean of seven wires from imperfect transits generally differs from the mean of seven wires observed, the perfect observations alone were employed. The transit instrument is by Ertel of Munich. The object-glass has a focal length of 6 feet, and the aperture is of 4.6 inches. The clock is a good one, by Molyneux of London.

"The computation was performed nearly in the manner recommended by Mr. Baily. Having got a good approximation to the longitude of George Town, the increase of the moon's right ascension between the two meridians was divided by the moon's hourly motion computed for the mean of the Greenwich times of observation. The result is, that the George-Town College Observatory is  $5^{\text{h}} 8^{\text{m}} 18^{\text{s}}.2$  West of Greenwich."

By a base of 957 feet, measured along the aqueduct leading the Chesapeake and Ohio Canal across the Potomac, and a Munich universal instrument, which reads off horizontal angles to  $10''$ , Mr. Curley found the distance between the National Observatory and the George-Town Observatory to be 8764.4 feet.

The direction of the National Observatory from the George-Town Observatory was observed to be  $56^{\circ} 44' 40''$  to the East of South. Hence, after allowing for the distance of the domes from the points of observation, the dome of the National Observatory is  $47''.4$  South and  $6''.2$  East of the dome of George-Town College Observatory.

From Mr. Kluskey, City Surveyor of Washington, the following differences of latitude and departure between the dome of the Capitol and the National Observatory were obtained, viz.—

Capitol Dome 1906 feet S., and 12158.8 feet E. of the National Observatory.

Adopting the position of George-Town Observatory, given above, Mr. Curley finds the following latitudes and longitudes :—

	North Lat.	West Long.
George-Town College, Dome .....	$38^{\circ} 54' 26''.0$	$5^{\text{h}} 8^{\text{m}} 18''.20$
National Observatory, Dome .....	$53^{\circ} 38' 58''$	$12''.00$
Capitol — Dome .....	$53^{\circ} 19' 87''$	$1''.74$
Old Naval Observatory, Lieut. Gilliss' Station	$38^{\circ} 53' 31''.61$	$5^{\text{h}} 8^{\text{m}} 1''.83$

i.e. following Lieut. Gilliss' statement, that it was 1200 feet N.W.  $5^{\circ}$  from the Capitol Dome.

Mr. Curley adds that the substance of the above account is taken from a MS. written two or three years ago, which contains a description of the instruments and some observations. Circumstances have not permitted him to get the MS. printed.

*On the Numerical Computation of the Values of Slowly-converging Series.* By Sir J. Lubbock, Bart. F.R.S. &c.

The numerical values of series which are incapable of direct summation, and which slowly converge, are sometimes required, as, for example, the quantities called *b* in the *Méc. Céle.*, which are so important in astronomy and so troublesome to compute.

Suppose the slowly converging series,

$$1 + x + x^2 + x^3 + \&c.$$

of which the Napierian logarithm is

$$x + \frac{x^2}{2} + \frac{x^3}{3} + \frac{x^4}{4} + \&c.$$

the series which expresses the Napierian logarithm evidently converges more rapidly than that which expresses the corresponding natural number; and as this is the case in other similar instances, it is desirable, especially with a view to tabulating numerical values, corresponding to different values of the variable, to have a ready mode of obtaining the numerical values of the coefficients in the series which expresses the logarithm of any series of this kind.

Let the series in question be represented by

$$1 + a_1 x + a_2 x^2 + a_3 x^3 + \&c.$$

and let the Napierian logarithm of this quantity be represented by

$$A_1 x + A_2 x^2 + A_3 x^3 + A_4 x^4 + \&c.$$

Differentiating,

$$\begin{aligned} A_1 + 2 A_2 x + 3 A_3 x^2 + 4 A_4 x^3 + \&c. \\ = \frac{a_1 + 2 a_2 x + 3 a_3 x^2 + 4 a_4 x^3 + \&c.}{1 + a_1 x + a_2 x^2 + a_3 x^3 + \&c.} \end{aligned}$$

Multiplying up and equating coefficients,

$$A_1 = a_1, \quad 2 A_2 + A_1 a_1 = 2 a_2, \quad 3 A_3 + 2 A_2 a_1 + A_1 a_2 = 3 a_3,$$

$$A_2 = a_2 - \frac{1}{2} A_1 a_1,$$

$$A_3 = a_3 - \frac{1}{3} A_1 a_2 - \frac{2}{3} A_2 a_1, \quad A_4 = a_4 - \frac{1}{4} A_1 a_3 - \frac{2}{4} A_2 a_2 - \frac{3}{4} A_3 a_1,$$

$$A_5 = a_5 - \frac{1}{5} A_1 a_4 - \frac{2}{5} A_2 a_3 - \frac{3}{5} A_3 a_2 - \frac{4}{5} A_4 a_1,$$

of which equations the law is simple and evident.

In order to illustrate these expressions by an example, suppose it were required to calculate the coefficients of the cosines of multiples of  $\cos \theta$  in the development of

$$\{1 - A \cos \theta\}^{-\frac{1}{2}}$$

this series may be expressed by

$$\mathfrak{B}_0 + \mathfrak{B}_1 \cos \theta + \mathfrak{B}_2 \cos 2 \theta + \mathfrak{B}_3 \cos 3 \theta + \mathfrak{B}_4 \cos 4 \theta + \&c.$$

$$\text{If } a = \frac{1}{2} \left\{ \sqrt{1+A} + \sqrt{1-A} \right\} \quad a' = \frac{1}{2} \left\{ \sqrt{1+A} - \sqrt{1-A} \right\}$$

$$\mathfrak{B}_0 = \frac{1}{a^2} \left\{ 1 + \frac{3 \cdot 3}{2 \cdot 2} \frac{a'^2}{a^2} + \frac{3 \cdot 5 \cdot 3 \cdot 5}{2 \cdot 4 \cdot 2 \cdot 4} \frac{a'^4}{a^4} + \frac{3 \cdot 5 \cdot 7 \cdot 3 \cdot 5 \cdot 7}{2 \cdot 4 \cdot 6 \cdot 2 \cdot 4 \cdot 6} \frac{a'^6}{a^6} + \&c. \right\}$$

$$\mathfrak{B}_1 = \frac{2}{a^3} \left\{ \frac{3a'}{2a} \right\} \left\{ 1 + \frac{5 \cdot 3}{4 \cdot 2} \frac{a'^2}{a^2} + \frac{5 \cdot 7 \cdot 3 \cdot 5}{4 \cdot 6 \cdot 2 \cdot 4} \frac{a'^4}{a^4} + \frac{5 \cdot 7 \cdot 9 \cdot 3 \cdot 5 \cdot 7}{4 \cdot 6 \cdot 8 \cdot 2 \cdot 4 \cdot 6} \frac{a'^6}{a^6} + \&c. \right\}$$

$$\mathfrak{B}_2 = \frac{2}{a^4} \left\{ \frac{3 \cdot 5}{2 \cdot 4} \frac{a'^2}{a^2} \right\} \left\{ 1 + \frac{7 \cdot 3}{6 \cdot 2} \frac{a'^2}{a^2} + \frac{7 \cdot 9 \cdot 3 \cdot 5}{6 \cdot 8 \cdot 2 \cdot 4} \frac{a'^4}{a^4} + \frac{7 \cdot 9 \cdot 11 \cdot 3 \cdot 5 \cdot 7}{6 \cdot 8 \cdot 10 \cdot 2 \cdot 4 \cdot 6} \frac{a'^6}{a^6} + \&c. \right\}$$

the quantities  $\mathfrak{B}$  are connected with the quantities  $b$  of the *Méc. Cél.* vol. i. p. 267, by the equations

$$\frac{1}{2} b_{\frac{1}{2}}^{(0)} = a^3 \mathfrak{B}_4, \quad b_{\frac{1}{2}}^{(1)} = a^3 \mathfrak{B}_1, \quad b_{\frac{1}{2}}^{(2)} = a^3 \mathfrak{B}_2$$

$$\text{If } \mathfrak{B}_0 = \frac{1}{a_1} B_0, \quad \mathfrak{B}_1 = \frac{3a'}{a_1} B_1, \quad \mathfrak{B}_2 = \frac{3 \cdot 5 a'^2}{4 a_1} B_2, \text{ \&c. and}$$

If  $\frac{a'^2}{a^2} = x$ , the expressions for  $B_0, B_1, B_2$  are of the form

$$1 + a_1 x + a_2 x^2 + a_3 x^3 + \&c.;$$

and the following table, calculated by Mr. Farley, shows the values of  $A_1, A_2, A_3$ , &c.,  $a_1, a_2, a_3$ , &c.; and it will be seen that the coefficients  $A$  converge, while, on the contrary, the coefficients  $a$  diverge.

	$B_0$	$B_{11}$	$B_{22}$		$B_0$	$B_{11}$	$B_{22}$
$A_1$	2'2500	1'5625	1'5326	$a_1$	2'2500	1'5625	1'5326
$A_2$	4'007	3'461	3'277	$a_2$	7'3280	3'2319	2'9896
$A_{10}$	1'992	1'838	1'731	$a_{10}$	13'6910	5'0339	4'4391
$A_{16}$	1'1330	1'1263	1'1192	$a_{16}$	20'0560	6'7571	5'7684
$A_{20}$	1'010	1'0964	1'0919	$a_{20}$	26'4210	8'4490	7'0460

In computing an isolated case of  $\mathfrak{B}$ , it would not be worth while to procure the values of  $A$ ; but in forming an extended table of the quantities  $\mathfrak{B}$ , they may be employed with advantage. The quantities  $A$  are also interesting, as affording the means of resolving any series into factors. See a recent memoir by M. Cauchy in the *Comptes Rendus*.

If the series

$$1 + a_1 x + a_2 x^2 + a_3 x^3 + \&c. = 1 + X,$$

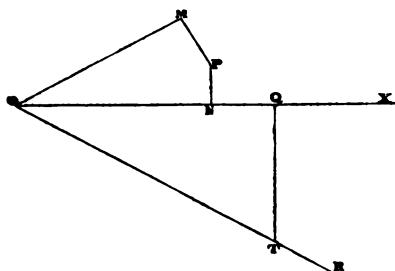
$$\text{the logarithm} = X - \frac{X^2}{2} + \frac{X^3}{3} - \frac{X^4}{4} + \&c.;$$

and, by expanding, the expression for the logarithm might be obtained in terms of  $a_1, a_2, a_3$ , &c.; but as the indices of the quantities increased, the law would not be easy to exhibit, and the equations would be altogether unmanageable for the computer.

*Description of an Instrument for calculating the Correction of a Transit Observation for Collimation, Level, and Azimuth Errors.* By Professor Challis.

“The collimation, level, and azimuth errors of a transit being respectively  $a, b, c$ , in seconds of space, the zenith distance of the observed object being  $z$ , and its north polar distance  $\delta$ , the instrument I am about to describe performs the calculation of  $(a + b \cos z + c \sin z) \times \frac{\operatorname{cosec} \delta}{15}$ , that is, the reduction of the observed time of transit to the time of meridian transit. The manner of

effecting this depends on the following geometrical considerations. For simplicity,  $a, b, c, z$ , and  $\delta$  will at first be supposed to be positive quantities. From an origin  $O$  draw a line of abscissæ  $O X$ , and another line  $O M$ , making with  $O X$  an angle equal to  $z$ .



Take  $OM$  equal in length to  $b$  on an arbitrary scale, and from  $M$  draw  $MP$  at right angles to  $OM$  towards  $O X$ , and equal in length to  $c$ . Then,  $P N$  being drawn perpendicularly on  $O X$ ,  $O N$  is the sum of the projections of  $OM$  and  $MP$  on  $O X$ , that is,  $b \cos z + c \sin z$ . Set off on  $O X$  the additional quantity  $N Q$  equal to  $a$ ; then  $O Q = a + b \cos z + c \sin z$ . Draw an indefinite line  $OR$ , making with  $O X$ , on the side opposite to  $OM$ , an angle equal to  $90^\circ - \delta$ , so that the angle  $MOR$  is equal to the latitude of the Observatory. Lastly, draw  $QT$  at right angles to  $O X$ , cutting  $OR$  in  $T$ . Then, if  $OR$  be made a scale of equal parts commencing at  $O$ , and if the unit of this scale be fifteen times the unit of the scale from which  $a, b$ , and  $c$  were cut off, it is clear that the reading  $OT$  will be  $O Q \times \frac{\operatorname{cosec} \delta}{15}$ , which is the quantity it was required to calculate.

"The preceding geometrical considerations apply in the mechanical construction of the instrument as follows. The point  $O$  is the centre of a brass circular plate, movable about a vertical axis passing through this point; and on the plate are engraved, first, the scale line  $OR$ , continued both ways from  $O$  across the plate, for the purpose of taking account of negative corrections, and next, two scale lines at right angles to each other, in both directions from  $O$ , to serve for setting off positive and negative level and azimuth errors, the positive direction of the scale line for level error making, with the positive direction of the correction-scale  $OR$ , an angle equal to the latitude of the Observatory. At a short distance from the circular plate, and in a direction parallel to the arbitrary fixed direction  $O X$ , there is placed a straight edge, for the purpose of guiding the motion of two bars, which carry two fine parallel threads of blackened unspun silk over the surface of the plate, the direction of the threads being perpendicular to the straight edge. The interval between the threads is made equal to the collimation error (without regarding its sign), by means of a scale engraved on a brass plate to which one of the bars is at-

tached, and an index fixed to the brass plate to which the other bar is attached, the two plates being clamped together by a screw, when the threads are set at the required interval. The screw-head serves for a handle to move the threads. For the purpose of setting the circle in any proposed instance, its upper surface is graduated close to the circumference from  $0^{\circ}$  to  $130^{\circ}$  of positive north polar distance, and from  $0^{\circ}$  to  $60^{\circ}$  of negative north polar distance, the place of the zero of the graduation being chosen arbitrarily. The fixed index which points to the north polar distance is in such a position that its reading is zero, when the scale O R coincides in direction with the threads and the positive side of the scale is directed *from* the straight edge which guides the motion of the threads. Also the direction in which the positive numbers of the graduation increase, is determined by making the reading  $+90^{\circ}$ , when the positive direction of O R coincides with the positive direction of O X.

“ According to these arrangements the calculation is performed simply as follows. First, the point P is marked on the circular plate by means of the level and azimuth scales, and the threads are separated by an interval equal to the collimation error by means of the collimation scale. These operations, once performed, apply to all observations for which the collimation, level, and azimuth errors are the same. Next, for a particular observation, the circle is moved till the index of the graduation points to the north polar distance of the object: then, the point P being bisected by one of the threads, the other cuts off from O R the distance O T, which being read by the scale is the quantity sought. The bisection of P is made by one or the other of the threads, according as the collimation error is positive or negative.

“ It is proper to mention several other details in the construction of the machine, and certain precautions for ensuring expedition and accuracy in the use of it. For marking readily the position of the point P, a ruled square, the sides of which serve for the level and azimuth scales, is engraved on the plate, its centre coinciding with the centre of motion of the circle. The side of the square is 6 inches, and half an inch corresponds to one second of space, so that the extent of the scales is  $\pm 6''$ . The ruled lines are one-twentieth of an inch apart, and, consequently, mark tenths of a second. By estimation the position of P may be marked to the hundredth of a second. The diameter of the circle is 15 inches, and the greatest amount of correction that can be read from the correction scale is  $\pm 1''$ . The hundredths of a second of time are marked on this scale, and thousandths may be read by estimation. The collimation-scale extends to  $7''$ . The two threads are adjustable to parallelism, and when the index of the collimation-scale points to zero, it is so arranged that one thread shall be vertically above the other, the threads being let into grooves at their extremities. The lower of the two pieces of brass to which the bars carrying the threads are attached, is fastened to a rectangular piece of box-wood, which slides in a brass trough, one vertical side of which

is the guiding edge for the common motion of the threads, and against the other a spring presses to keep the box-wood close to the guiding surface. The trough rests on three screws working in the mahogany support of the instrument, and is adjustable to position by means of these screws. The words "Collimation," "Level," and "Azimuth," are engraved to distinguish the scales, and the directions in which the co-ordinates of P are to be set off are indicated by the signs + and —. Also the figures of the correction-scale have the signs + or — attached to them. The bars carrying the threads have the letters A and B engraved on them, and a card stuck in a bracket indicates which of the two threads is to be used for the bisection of P, by reference to one or the other of these letters, according as the collimation-error is positive or negative. A black-lead pencil will mark the place of P with sufficient distinctness on the brass plate by two short intersecting lines, and the lines can be readily effaced. The above precautions make it almost impossible to commit any mistake in the use of the instrument.

"It remains to mention the advantages which the instrument offers, and the degree of accuracy of which it is susceptible. For calculating the reduction to meridian transit, it has been usual to form a table of the coefficients of the collimation, level, and azimuth errors, the argument of which is the north polar distance, whence the coefficient for a proposed north polar distance may be readily deduced for insertion in the transit calculation-book. This being done, the calculation consists of three multiplications and three additions for each object. For the sake of saving time the multiplications are performed by a sliding scale. To give an idea of the advantage gained by the new instrument, it may be stated that it saves the trouble of inserting the coefficients, and the operation for obtaining the whole correction occupies no more time than one multiplication by the sliding scale. The common method may be inaccurate to one hundredth, or even two hundredths of a second, if the errors of the multiplications all lie in the same direction, whilst the machine by moderate care will give the nearest hundredth of a second. It is, however, to be said, that the indications of the instrument become more uncertain in proportion as the north polar distances are less, on account of the small inclination of the threads to the correction-scale, and that in the above construction this scale is too short to allow of reading off for north polar distance less than  $30^\circ$ , when the level and azimuth errors are greater than  $5''$  and of opposite signs, and the collimation-error is greater than  $2''$ . To meet the case of small north polar distances an additional scale is engraved on the upper edge of that side of the trough which guides the threads, the unit being a second of space. The zero of the scale coincides with the position of a thread when it bisects the centre of the circle, and the positive numbers increase in the positive direction of O X. The process for reading off from this scale is precisely the same as for the correction-scale, but the quantity read off is  $a + b \cos z + c \sin z$ ;

which has to be multiplied by the coefficient for collimation-error. Even this use of the instrument saves considerable time, and for stars near the pole, as *Polaris*, I find it to be somewhat more accurate than the ordinary method.

"The construction of the instrument, which required no little nicety of workmanship, has been executed for me by Mr. Simms in a very satisfactory manner.

"If the instrument be used in a latitude different from that for which it was constructed, a slight additional calculation will be required for determining the position of the point P, which may be performed by the instrument itself. For if  $l$  be the colatitude of the observatory for which the instrument was made, and  $z$  the zenith distance of an object, and if  $l'$ ,  $z'$  be the corresponding arcs for another observatory, we have,

$$\begin{aligned} a + b \cos z' + c \sin z' &= a + b' \cos z + c' \sin z, \\ \text{if } b' &= c \sin (l - l') + b \cos (l - l') \\ \text{and } c' &= c \cos (l - l') - b \sin (l - l') \end{aligned}$$

Hence  $b'$  and  $c'$  are the co-ordinates of P to be used at the latter place."

*Description of an Instrument for obtaining the Corrections to be applied to Transit Observations.\** By Mr. R. C. Carrington, of the Observatory, Durham.

Mr. Carrington, having heard that Professor Challis had proposed an instrument for correcting transit observations, set himself to work to solve the same problem. Finding his construction different from that of Professor Challis, he has had his instrument executed by Messrs. Troughton and Simms, and presented it to the Astronomical Society.

Expanding the usual formula, viz.

$$\frac{c}{\sin \delta} + \frac{i \cos (\delta - l)}{\sin \delta} + \frac{a \sin (\delta - l)}{\sin \delta},$$

( $c$ ,  $i$ , and  $a$  being the collimation, inclination, and azimuth corrections in units of 15"),

Mr. Carrington arrives at the equivalent formula,

$c'' + c' \cotan \delta + c \operatorname{cosec} \delta$ ; where  $c$  remains as before, and

$c' = i \cos l - a \sin l$ , and  $c'' = i \sin l + a \cos l$ .

The geometrical construction on which Mr. Carrington's instrument depends, is this.

\* In May last, the President particularly called the attention of the meeting to Mr. Carrington's instrument, and to Mr. Johnson's beautiful and accurate annual volume of observations.

Draw an indefinite right line divided into a scale of equal parts each representing  $1''$ . Cut off from the beginning a portion  $= c''$ ; at the point of section erect a perpendicular which make  $= c'$ , draw from the extremity of this perpendicular a line making an angle  $= 90 - \delta$  with it, and also draw a parallel to this line at the distance  $c$  from it; the last-drawn line will cut off from the original line a part equal the sum of the corrections. For, as will be easily seen, the intercepted points by the two parallel lines are respectively the cotangent and cosecant of  $\delta$  to the respective radii  $c'$  and  $c$ .

The foregoing construction is very ingeniously reduced to practice by Mr. Carrington, but it would not be easy to make the matter intelligible without drawings.

Any person who is interested in the subject may inspect the instrument, and Mr. Carrington's explanation of its use, at the Society's apartments. Mr. Carrington "believes that the instrument will work to two places of decimals for all stars not less than  $5^\circ$  distant from the pole, and that a mistake in sign, or in the place of the decimal points, is rendered impossible." Mr. Carrington adds, "I allude to Professor Challis's instrument merely to recall the fact that his preceded mine."

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*Note on correcting Series of Transit Observations for Instrumental Error.* By Mr. Sheepshanks.

The mechanical contrivances of Professor Challis and Mr. Carrington for this purpose, induce me to mention a method which, under certain circumstances, I found very convenient for freeing transit observations from instrumental error. Starting from the well-known formula, that the sum of corrections may be represented by  $m + n \tan \text{Dec} + c \sec \text{Dec}$  ( $m$  and  $n$  are, with me, unknown quantities, to be determined from the observations themselves,  $c$  the unknown correction for collimation), I observed a large number of stars on one night, and the same stars on a following night, *with the instrument reversed*. Then, since the collimation changes its sign, and the new values of  $m$  and  $n$  have the same factors as before, the observed place of the star deduced from a mean of the two nights, required a correction of  $m' + n' \tan \text{Dec}$ , the collimation being eliminated. If the rate of the clock was considerable, the observations were corrected for rate before taking the means. I then selected the Greenwich stars near the pole, *Polaris* or  $\delta$  *Ursæ Minoris* if possible, and the Greenwich stars near the equinoctial, and from these two groups obtained the value of  $m'$  and  $n'$ , which were generally found with extreme accuracy. All the unknown stars were then corrected by applying  $m' + n' \tan \text{Dec}$  to their mean results from the two nights' observations.

To facilitate the computation, I had cards printed of the natural tangents and secants of declination to  $90^\circ$ . (These may be procured at the Society's apartments.) The advantages are that in *cataloguing* you save the trouble of determining the level

azimuth and collimation errors, and if your instrument be faultless, and the Greenwich catalogue perfect, have no error left except the mere error of observation, which, when fourteen wires are noted, is very trifling. There is only one reduction to the mean place for two observations. Some observations of my own, and some made by Mr. Hartnup at my request, lead me to think that in two fine nights, a catalogue of quick moving stars may be formed, in which an error of  $0^{\circ}.05$  would be somewhat unusual.

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*On the Weights to be given to the separate Results, and to the final Result, for Terrestrial Longitudes determined by the Observations of Transits of the Moon and Fixed Stars.* By the Astronomer Royal.

This paper contains the investigations for the principal cases which occur in practice. The *weight* of any one observation is taken as the reciprocal of the square of the probable error in seconds of time. The combination-weight of an observation is the number by which it is to be multiplied, in combining it with the results of other observations.

Case 1. The transits of the moon and one star, on a single evening, are compared with the places in the *Nautical Almanac*, considered as perfectly accurate: to find the weight and probable error of the result.

To find the weight of the result;—Form the fraction whose numerator is the product, and whose denominator is the sum, of the weights of the moon-observation and the star-observation, multiply this fraction by  $\left(\frac{1}{3600}\right)^2$ : the product is the weight of the result.

Case 2. Transits of the moon and several stars, observed in one evening, are compared with the places in the *Nautical Almanac*, supposed accurate.

The combination-weights for the several results will be the weights of the star-observations, without respect to the observation of the moon.

To obtain the weight of the final result;—Form the fraction whose numerator is the product of the weight of the moon-observation by the sum of the weights of the star-observations, and whose denominator is the sum of the weights of the moon-observation and the star-observation; multiply this fraction by  $\left(\frac{1}{3600}\right)^2$ : the product is the weight of the final result.

It will easily be seen, from this rule, that very little is gained by increasing the number of *stars* observed on the same night.

Case 3. Transits of the moon and several stars are observed at the primary station, and transits of the moon and several stars (it matters not whether the number of stars is the same, or whether

the stars are identical) are observed at other stations on the same night; the tabular places of the stars are supposed perfectly accurate, but those of the moon are liable to error: to find the combination-weights and the weight of the result.

For the determined right ascension at each station: the combination-weight for the result as to moon's right ascension determined from each star will be the weight for that star, without respect to the observation of the moon. But the weight of the result for moon's right ascension determined at that station will be the fraction whose numerator is the product of the moon's weight by the sum of the weights of the stars, and whose denominator is the sum of the weights of the moon and the stars.

When the weight for each station is thus found, then the combination-weight to be used for the result for terrestrial longitude, inferred from comparison of the moon's right ascension determined at the primary station with the moon's right ascension determined at a comparison-station, is to be the weight for that comparison-station (as found in the preceding paragraph), without respect to the primary station. But the weight of the final result for terrestrial longitude will be found by forming the fraction whose numerator is the product of the weight for the primary station by the sum of the weights for all the comparison-stations, and whose denominator is the sum of the weights for the primary station and all the comparison-stations, and multiplying this fraction by  $\left(\frac{1}{3600}\right)^2$ , the product is the weight of the final result.

The following cases suppose no reliance on tables, either of the moon or stars:—

Case 4. Transits of the moon and one star at the primary station are compared with transits of the same objects at one comparison-station.

The weight of the result is the reciprocal of the sum of the reciprocals of the weights of the four observations, multiplied by  $\left(\frac{1}{3600}\right)^2$ .

Case 5. Transits of the moon and several stars observed at the primary station are compared with transits of the same objects at one comparison-station.

The combination-weights, for combining the results of the comparisons with the different stars, will depend only on the weights of observations of the stars, without respect to the observations of the moon.

The combination-weight for the result derived from comparisons with one star, will be the fraction whose numerator is the product of the two weights for that star, and whose denominator is the sum of those weights.

Suppose a similar weight to be formed in the same way from the moon-observations.

Then for the weight of the final result, form the fraction whose numerator is the product of the moon-weight, by the

sum of the star-weights, and whose denominator is the sum of the moon-weight and the star-weights, multiply this fraction by  $\left(\frac{1}{3600}\right)^2$ , the product is the weight of the final result.

Case 6. Transits of the moon and a single star are observed at the primary station, and at several comparison-stations.

The combination-weights for the results derived from comparison with the different stations will depend only on the weights of the observations of the moon and star at the comparison-stations, without respect to those at the primary station.

The combination-weight for each comparison-station will be the fraction whose numerator is the product of the weights of the moon and the star, and whose denominator is their sum.

Suppose a similar weight to be formed for the primary station.

Then the weight of the final result is formed by forming the fraction, whose numerator is the product of the primary-station weight by the sum of the comparison-station-weights, and whose denominator is the sum of the primary-station weights and comparison-station weights: and multiplying this fraction by  $\left(\frac{1}{3600}\right)^2$ , the product is the weight of the final result.

Case 7. Transits of the moon and several (*e*) stars are observed at several (*f*) stations, besides the primary station on the same evening, the same stars being observed at all.

The general case having been treated, the particular case is fixed on in which all the moon-observations have equal probable errors (each =  $\mu$ ), and also all the star-observations (each =  $\pi$ ). The weight of the result is, then,

$$\left(\frac{1}{3600}\right)^2 \mu \times \text{reciprocal of } \left(1 + \frac{1}{f} + \frac{1}{e} \left(1 + \frac{1}{f}\right) \frac{\mu}{\pi}\right).$$

Case 8. As an instance of the case in which all the stars are not observed at all the stations, the following is taken.

At the primary station five stars are observed with the moon. Of these, the 1st, 2d, and 3d, are also observed with the moon at the first comparison-station; the 1st and 4th at the second comparison-station; and the 1st, 4th, and 5th, at the third comparison-station. All the observations of the moon are supposed equally good, and all the observations of the stars are supposed equally good.

The general formulæ having been considered, it is supposed that the moon and star-observations are equally good; and then, *V*, *W*, *X*, *Y*, *Z*, referring to the five stars, and the subscript numbers to the stations, the combination-weights  $V_1, W_1, X_1, V_2, Y_2, V_3, Y_3, Z_3$ , are found to be in the proportions of the numbers 33, 100, 100, 85, 96, 49, 60, 108. The weight of the final result is,—

$$.5930 \times \left(\frac{1}{3600}\right)^2 \times \mu.$$

The individual results receive smaller combination-weights

when derived from those stations with which there is the greater number of comparisons. Again, the individual results receive smaller combination-weights when derived from comparisons made by means of stars observed at more stations. And, to illustrate the smallness of the advantage (compared with what would probably be expected) gained by increasing the number of stations and of comparisons, the probable error of the result in the above case is less than that of one comparison with one station, only in the proportion of 20 to 13.

In practice, approximate expressions for the weights, sufficiently near the truth, may be found by the following process. Set down in the form of a table of double entry, whose arguments are "stars observed" and "comparison-stations," points or marks indicating the observation. For every observation at a comparison-station where 1, or 2, or 3, or 4, &c. stars have been observed, set down the fraction  $\frac{1}{1}$ , or  $\frac{1}{2}$ , or  $\frac{1}{3}$ , or  $\frac{1}{4}$ , &c. For every observation of a star which has been observed at 1, or 2, or 3, &c. comparison-stations, set down the fraction  $\frac{1}{1}$ , or  $\frac{1}{2}$ , or  $\frac{1}{3}$ , or  $\frac{1}{4}$ , &c. The products of these fractions will give nearly enough the weight for each comparison, and the sum of all the products multiplied by  $\left(\frac{1}{3600}\right)^2 \times \mu$ , will give nearly enough the weight of the whole. Thus, in the instance above:—

		Stars Observed.																			
		1 <sup>st</sup>				2 <sup>d</sup>				3 <sup>d</sup>				4 <sup>th</sup>				5 <sup>th</sup>			
Comparison- Stations.		Observed.	Station Number.	Star Number.	Product, or Weight.	Observed.	Station Number.	Star Number.	Product, or Weight.	Observed.	Station Number.	Star Number.	Product, or Weight.	Observed.	Station Number.	Star Number.	Product, or Weight.	Observed.	Station Number.	Star Number.	Product, or Weight.
1	*	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{16}$		*	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{8}$	*	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{8}$								
2	*	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{9}$										*	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{9}$				
3	*	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{16}$										*	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{12}$	*	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{8}$

The numbers thus obtained are rather less unequal than those found by the accurate investigation; and the weight of the final result,  $\mu \times \left(\frac{1}{3600}\right)^2 \times \frac{7}{9}$ , is rather greater than that found by the accurate investigation. But as the rule answers exactly in extreme cases (whether the number of stations and the number of stars, or either of them, be very great or very small), it cannot err much in intermediate cases. It would be sensibly erroneous if a single different star were observed at every different station; but in this case the independent investigation would be very easy.

Case 9. Observations of any or several of the preceding classes are made on different evenings.

The combination-weights for the results of different evenings are to be the weights found by the preceding investigations. And the weight of the final result will be the sum of these weights.

The attention of observers is particularly called to the circumstance that this is the *only* combination by which the weight of results is greatly increased. In all the preceding cases, however much the number of stars or number of comparison-stations was increased, the weight of the result could not be increased beyond a value very little greater than that for a single star at a single comparison-station. But by increasing the number of nights of observation, the weight of the final result may be increased without limit.

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*Measures of  $\epsilon$  Bootis, by Mr. Fletcher.*

"By a mean of four nights' measures of this star, taken under very favourable circumstances with the 6-foot equatoreal, I find,

Position  $321^{\circ} 40'$ . Distance  $2'' 93$ . Epoch  $1850 \cdot 41$ .

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*Note from Professor Piazzzi Smyth.*

"A careful examination of the heavens in a clear night has satisfied me that the stars in Lalande, 33239 and 33244, are the same. I find the following mean places with the transit and mural circle, Epoch  $1850 \cdot 48$  :—

	Mag.	R.A.	Obs.	N.P.D.	Obs.	Epoch.
		<sup>h</sup> <sup>m</sup> <sup>s</sup>		<sup>o</sup> <sup>'</sup> <sup>"</sup>		
Lalande { 33239 }	7	17 55 50 <sup>s</sup> 68	(3)	15 24 29 <sup>"</sup> 1	(3)	1850 <sup>s</sup> 48
{ 33244 }						

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*On the Comet seen by Mr. Jenkins in November last.*

In the *Monthly Notice* of March last, some account is given of a comet seen by Mr. Jenkins on his voyage to Rio Janeiro. It was supposed at the time that the comet thus seen might be the comet of long period which was expected in 1848, and further inquiry was made to ascertain the particulars more accurately.

Mr. Jenkins unfortunately died at Rio, but Captain Horner, the master of the Maryland (the vessel in which Mr. Jenkins sailed), states that the comet was seen on Nov. 15th, sea account : that the true time on board was 7<sup>h</sup> 30<sup>m</sup> P.M., latitude  $13^{\circ} 32'$  South, long.  $34^{\circ} 50'$  West.

The bearing of the comet from the ship was W.N.W., altitude of the nucleus  $48^{\circ}$ , and its course S.E. and N.W.; it was in sight about an hour.

Mr. Hind remarks that these data differ considerably from those previously received. The place of the comet, according to Captain Horner's particulars, would be,

R.A.  $20^h 36^m 6$ . N.P.D.  $85^{\circ} 42'$  Nov. 15, at  $9^h 49^m$  G.M.T.

This position is quite irreconcilable with the track of the great comet of 1848 laid down by Mr. Hind, and establishes his opinion that the body seen by Mr. Jenkins is not the expected comet. M. Bomme's investigations, however, have shown that the return of the expected comet will yet be delayed for a considerable period.

Mr. Heath proposes the following rule for converting sidereal into solar time, and *versâ vice*, when the computer has no tables to assist him :—

The datum is the proposed time, solar or sidereal. The correction is thus obtained :—

Write down the proposed time, considering the hours as minutes; the minutes as seconds, after reducing the seconds to decimals of a minute; call this *a*. Write under this the same number, again considering the minutes as seconds, and reducing to decimals, as before; call this *b*. Subtract *b* from *a*, and divide the remainder by 6; this quantity is very nearly the reduction of the given to the proposed time, being *added* if the given time is mean solar time, and *subtracted* in the contrary case.

Where great accuracy is required, a small quantity is to be applied to the datum and to its correction.

Add to *b* one-third of its value, and carry the decimal point two places to the left. This is then to be added to the given time; call the result *t*.

Add to *b* one-thirtieth of its value, and carry the decimal point two places to the left. This is then to be added to the correction already found; call the result *t'*.

Then  $t \pm t'$  is  $\left\{ \begin{array}{l} \text{Sidereal} \\ \text{Solar} \end{array} \right\}$  Time for the Datum in  $\left\{ \begin{array}{l} \text{Solar} \\ \text{Sidereal} \end{array} \right\}$  Time.

$$\begin{array}{rcl} \text{Given Time} & = & 23^{\text{h}} 56^{\text{m}} 4^{\text{s}}.09 \\ a & = & 23 \ 56.07 \\ b & = & \underline{23.93} \\ \text{Difference} & = & 23 \ 32.14 \\ \text{Correct.} = \frac{1}{6} & = & 3 \ 55.36 \end{array}$$

If great accuracy is required :—

$$\text{Addition to Datum} = \frac{23.9 + \frac{1}{3} 23.9}{100} = 0^{\text{s}}.32; t = 23^{\text{h}} 56^{\text{m}} 4.41$$

$$\text{Addition to Correct.} = \frac{23.9 + \frac{1}{30} 23.9}{100} = 0^{\text{s}}.25; t' = 3 \ 55.61$$

$$\begin{array}{l} 23^{\text{h}} 56^{\text{m}} 4.41 + 3 \ 55.61 = 24 \ 0^{\text{m}} 0.02 \text{ Sid. Time} = 23^{\text{h}} 56^{\text{m}} 4.09 \text{ Solar Time.} \\ 23^{\text{h}} 56^{\text{m}} 4.41 - 3 \ 55.61 = 23 \ 52 \ 8.80 \text{ Solar Time} = 23^{\text{h}} 56^{\text{m}} 4.09 \text{ Sid. Time.} \end{array}$$

*On a Universal Reference Number for Star Catalogues.*

By Mr. Drach.

To remedy the inconvenience of such discordant nomenclatures as Bradley 2493, B.A.C. 6736, &c., Mr. Drach suggests that a star should be numbered by the number of seconds contained in its right ascension, and that when one or more stars have the same second of right ascension, they should be distinguished by appending letters of the alphabet, as A, B, C, for northern stars, *a, b, c*, for southern stars. Thus a star numbered 6736 would be a star having a right ascension of 6736<sup>s</sup> or 1<sup>h</sup> 52<sup>m</sup> 16<sup>s</sup>.

This method would be very simple if we divided the circle decimally; perhaps with our sexagesimal divisions it might be more convenient to separate the hours, as in Piazzi, and to set each star down by its hour of right ascension, with the overplus in seconds: thus, instead of 6736, to write 1, 3136, somewhat as Piazzi has done.\*

Mr. Drach appends a list of the doublet and triplet stars in the B.A.C., *i.e.* of those stars which fall under the same second, and which, therefore, would require additional distinguishing symbols. There is only one quadruplet.

\* It would not be easy to give *permanent* names thus, as precession alters the stars every year, and in very different ways.

## ERRATUM.

Vol. x., p. 158, for  $\gamma$  Draconis, read  $\gamma$  Virginis.

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## ERRATA.

Vol. IX. p. 221, *Ceres*, July 13, Comp<sup>d</sup>—Obs<sup>d</sup> R.A., for + 12<sup>h</sup> 64, read + 11<sup>h</sup> 64.

Vol. X. — 23, line 11, for August 19, read August 10.

— — 25, — 25, for Hipplesey, read Hippisley.

— — 40, — 26, for Leary not mounted, read Carey not inverted.

— — 50, — 16 from the bottom, for any, read my.

— — 94, — 24, for 373397.7, read 37339.7.

— — 138, — 32, for 1½-inch pine boarding, read ½-inch pine boarding.

— — 142, — 13 from bottom, for + 17°, read + 71°.

— — 158, for  $\gamma$  *Draconis*, read  $\gamma$  *Virginis*.

— — 182, line 2, for  $\frac{a^{12}}{a^2}$ , read  $\frac{a'^2}{a^2}$ .

— — 193, — 24, for add to, read take from.

last line but two, for  $\frac{23.9 + \frac{1}{100} 23.9}{100} = 0^{\text{h}} 25$ ;  $t = 3^{\text{m}} 55^{\text{s}}.61$ ,

read  $\frac{23.9 - \frac{1}{100} 23.9}{100} = 0^{\text{h}} 23$ ;  $t' = 3^{\text{m}} 55^{\text{s}}.59$ .

last line but one, and last line,

	<sup>h</sup>	<sup>m</sup>	<sup>s</sup>		<sup>h</sup>	<sup>m</sup>	<sup>s</sup>
for 23	56	4.41	+ 3	55.61	= 24	0	0.02,
read 23	56	4.41	+ 3	55.59	= 24	0	0.00.
for 23	56	4.41	- 3	55.61	= 23	52	8.80,
read 23	56	4.41	- 3	55.59	= 23	52	8.82.

















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